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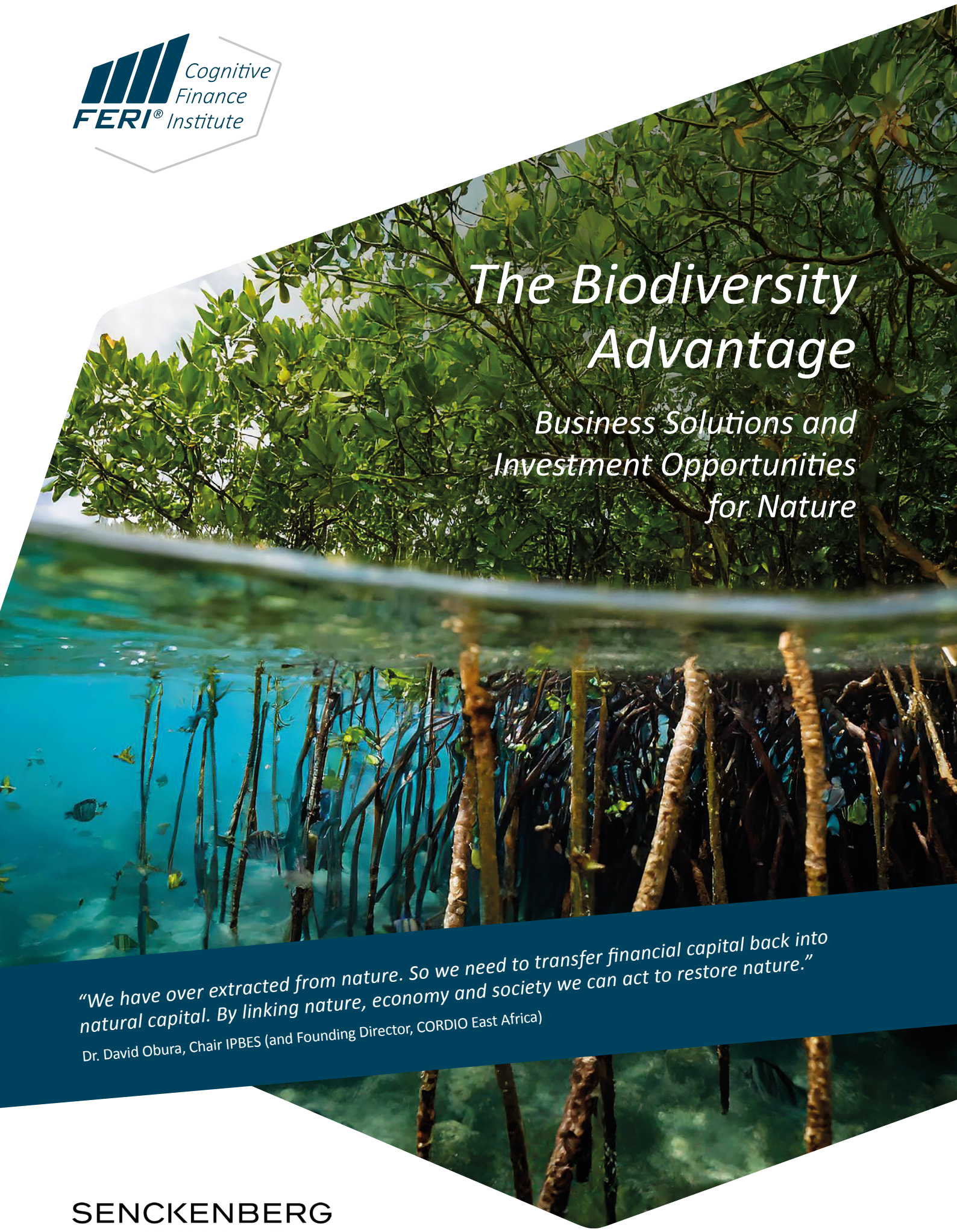
The Biodiversity Advantage

Business Solutions and Investment Opportunities for Nature



"We have over extracted from nature. So we need to transfer financial capital back into natural capital. By linking nature, economy and society we can act to restore nature."

Dr. David Obura, Chair IPBES (and Founding Director, CORDIO East Africa)

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The Biodiversity Advantage

Business Solutions and Investment Opportunities for Nature

Antje Biber
Dr. Tobias Raffel
Prof. Dr. Klement Tockner

“We often talk of saving the planet, but the truth is that we must do these things to save ourselves.”

David Attenborough, British biologist, naturalist
quoted after: Attenborough, D. (2020, Our Planet)

“Healthy, species-rich and functional ecosystems make a major contribution to mitigate climate change. If we act quickly and thoughtfully, this will benefit sustainability in many ways.”

Almut Arneth, Institute of Meteorology and Climate
at the Karlsruhe Institute of technology (KIT)
quoted after: Helmholtz-Klima-Initiative (2022, Biodiversität Klimaschutz)

“In the fight against biodiversity loss, data-driven strategies are pivotal. AI as a monitoring solution can transform raw data points into actionable intelligence, empowering decision-makers to gain unparalleled visibility into ecosystem health.”

Florian Geiser, Co-Founder & CEO Hula Technologies GmbH
quoted after: Hula Technologies (2024, Biodiversity Investments)

source cover image: AI-generated image: with Adobe Firefly, 2024
Prompt: Blick von unten auf eine Mangrove aus dem Wasser mit hoher Fischpopulation

Bad Homburg/Frankfurt, May 2024

Preface

Dear readers,

biodiversity, the intricate and highly dynamic fabric of life that encompasses all living organisms on Earth, is fundamental to the health and resilience of our planet. It constitutes a complex network of interactions and diversity, is vital for creating and sustaining ecosystems, provides essential support and sustenance, and enriches or even enables human well-being. Yet, in the face of unprecedented environmental challenges and escalating species loss rates, both of which are clearly driven by human action and intervention, understanding and safeguarding biodiversity have become existential tasks and imperatives of our time.

In this pursuit, the role of science and society is paramount, guided by well-informed politics. However, the alignment and participation of the global financial industry is equally important. Financing the long-term preservation of biodiversity, from pioneering technologies to large-scale conservation projects, depends on economic incentives and smart frameworks to attract investors. Global politics has to catch up quickly and must rise to the biodiversity challenge. Anticipated technological and regulatory changes will create new opportunities, but also the necessity for quick adaption, disrupting traditional systems.

As the world is forced to move towards sustainable systems, balancing economic progress with environmental responsibility, humanity must aim for a future where biodiversity can flourish. Critical problems of "overconsumption" – destroying critical ecosystems by taking too much from the planet's natural resources – have to be addressed with a focused approach. For all parties involved, it is absolutely crucial to understand the benefits of biodiversity conservation – for environmental safety, social stability, and economic advancement. Strategic investors and asset owners should endorse this reality and fully recognize the urgency. Why? Because they can be important drivers of change and will play a crucial role in the forthcoming transformation.

Learn more about the multifaceted nature of biodiversity, explore its various dimensions, drivers, and the impact mechanisms behind the financial potential of biodiversity conservation.

We hope you enjoy reading this study!

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1 Executive Summary

Antje Biber, Dr. Tobias Raffel, Prof. Dr. Klement Tockner

> *We often talk of saving the planet, but the truth is that we must do these things to save ourselves.*
>
> — David Attenborough, A Life on Our Planet: My Witness Statement and a Vision for the Future

- Biodiversity, underpinning more than **50 % of global economic services** and human livelihoods, provides essential goods and services for ecosystems, human food, health and well-being, economies and innovation.

- The interdependence of **biodiversity and human health** as the natural basis for pharmaceuticals and well-being is obvious, but often underestimated in its magnitude. 50 % of medicines approved in the last 30 years are either directly or indirectly derived from natural products, and 70 % of medicines used to treat cancer are derived from or inspired by nature. Over 4 billion people are estimated to depend primarily on natural remedies.[1]

- The link between **biodiversity and food security** is also fundamental. Over 75 % of food crops depend on pollination. The genetic diversity of plant species is crucial for feeding more than 8 billion people. Increasing plant diversity by rotating crops over time, diversifying agricultural landscapes or using pest-resistant plants can increase agricultural production and reliability.

- **Biodiversity and climate** are inextricably linked and highly interdependent. Marine and terrestrial ecosystems **sequester 60 % of global anthropogenic carbon emissions**.[2] Simultaneously, ecosystem degradation such as deforestation, peatland drainage, urbanisation or pollution can reduce carbon stocks and **diminish thermal buffers**.

- Meanwhile, **climate change** is increasingly becoming a **major driver of biodiversity loss**. That is resulting in the reduction of suitable habitats, causing range shifts and displacements of species, and furthermore pushes species beyond their tolerance and adaptation limits. In addition to climate-related negative impacts, global biodiversity loss is exacerbated by **agricultural land use and degradation**, direct overexploitation (e.g. overfishing), pollution and invasive species.

- These drivers do not act in isolation, but **interact and have additive, cumulative or synergistic effects** on both nature and humans, leading to non-linear changes and multiple feedback loops.

- A key requirement for a successful paradigm shift to end human caused mass extinction is a focus on **ecosystem multifunctionality** through a mix of conservation and restoration measures.

- The global shift towards an economy that protects and sustainably utilises nature and biodiversity require comprehensive political action. The recently launched and ground-breaking **Global Biodiversity Framework (GBF)** will provide the basis for slowing or even halting biodiversity loss. Its importance cannot be underestimated, and its significance for the future of humanity is certainly on a par with the 2015 Paris Agreement.

[1] IPBES (2019, Global Assessment Report).

[2] IPBES (2019, Global Assessment Report).

- The **European Union is a global leader in biodiversity ambition and regulation**, despite recent headwinds to sustainability policies and narratives. Three initiatives – the European Green Deal, the EU Biodiversity Strategy and the new EU Nature Restauration Law – highlight European efforts to set nature and biodiversity policy goals and translate them into legal requirements for businesses and the financial sector.

- Financial regulation is evolving at a rapid pace worldwide, alongside multilateral agreements and national implementation in legislation and taxation. All these measures are intended to **redirect financial flows and will lead to profound changes** in many economic sectors. This will create new incentives, revenue streams and investment decision-making principles.

- The broad and complex issue is implementation: **how to find solutions** that have a positive impact on biodiversity, prevent destruction and deliver the necessary economic benefits? The key is to implement solutions such as **nature-based solutions (NbS**), which use nature to sustainably manage and restore natural ecosystems, or **technology-based solutions (TbS)**, which use innovative technologies to protect, restore and enhance biodiversity and the services provided by ecosystems. There is also a third approach, **hybrid solutions**, which are a combination of nature-based and technology-based solutions.

- The **footprint, handprint, heartprint** is a pragmatic approach for companies to start taking action on biodiversity while applying a comprehensive and positive narrative that goes beyond risk analysis and regulatory compliance: Reduce negative impacts (footprint), increase positive impacts (handprint) and create transformative impacts (heartprint).

- **Financial institutions** are on the one side directly affected by the physical risks arising from the economy's dependence on nature. On the other side, the same financial market participants are exposed to long-term transition risks due to the negative impacts of economic activities on nature. Driven by investor demand and the need for practical action, an ever-expanding field of diverse investment opportunities across asset classes is emerging.

- **Biodiversity credits** can be a promising tool for bridging the funding gap for nature and environmental conservation. They can be used, for different purposes, to enhance carbon credits for better nature outcomes, as a business driver to demonstrably improve the environmental impact of products, and as a corporate commitment and contribution. However, a key success factors will be future global standards and reliable verification systems to avoid greenwashing and questionable offsetting practices.

- **Blended finance** is another well-known way of investing in targeted conservation and restoration activities. Collaboration between public institutions and private investors in blended finance has the advantage of economies of scale and risk mitigation of the invested projects.

- A promising investment opportunity that also meets the expectations and constraints of large investors in particular are **labelled bonds**. It is expected that national development banks and supranational institutions, as well as corporations, will increasingly issue these bonds with a dedicated environmental funding purpose.

- **Technology-based innovations in Private Markets** offer high-return investment opportunities attractive to yield-oriented investors. By investing in blue and green technologies, investors can not only generate sustainable returns, but also improve soil health, optimise water use, reduce carbon emissions, and help restore nature and the oceans.

- So-called novel **dual-use infrastructure projects** can be a promising way to enhance biodiversity combined with clean energy, which not only helps to mitigate climate change but also has a positive impact on ecosystems. Combining offshore wind with low-trophic aquaculture can provide sustainable energy, nutritious seafood and restorative ecosystem services.

- Direct investment in **farmland and forestry** should focus on **regenerative** forms of use. This form of cultivation focuses on regenerating the ground, improving the water cycle and promoting bio-storage, thereby increasing resilience to climate change and strengthening the health and vitality of the soil.

- To address **measurement and data challenges**, there is a **growing need for standardised methodologies** and reporting frameworks that explicitly capture the biodiversity impacts of financial instruments.

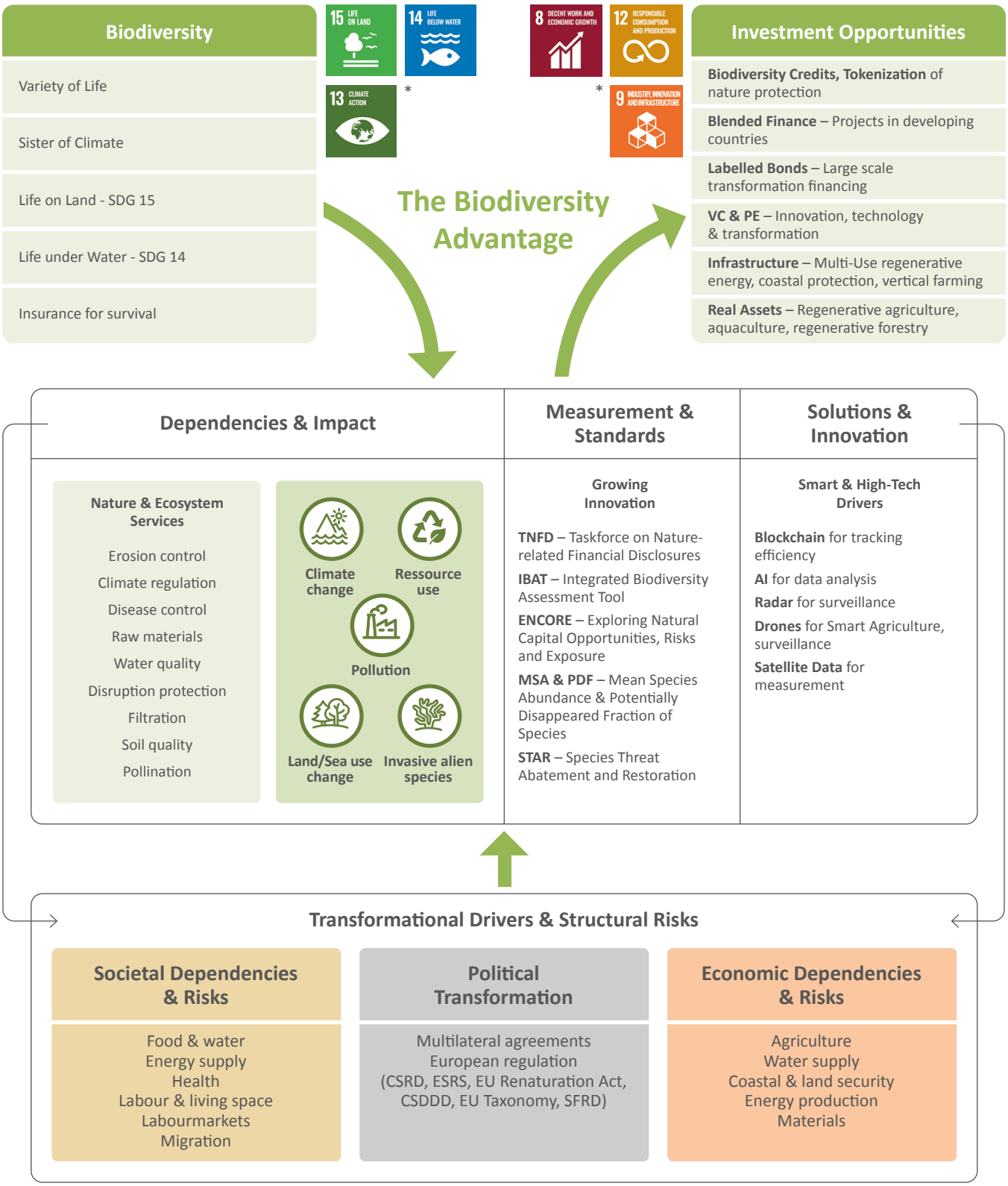
- In principle, a large number of **scientifically based measurements already exist**. Using modern technologies, such as AI blockchain and satellite data, these measurements can and will be improved on an exponential scale. The most important guidance for companies and investors is the **Taskforce on Nature-related Financial Disclosures (TNFD)** as a global framework for disclosing their nature-related dependencies and impacts.

- However, a hugely important driver of change in traditional industries, particularly agriculture, has been a **shift in priorities** in political culture and regulation.

- In the light of the targeted orientation of national legislation towards the implementation of the ***GBF,*** the *SDG* and even concrete guidelines for sustainable investment *(EU taxonomy),* the field of strategic investment decisions needs to be reorganised.

- In addition to emerging conservation initiatives, banks, insurers and investors are increasingly aware that their financial activities have a major impact on the **health of nature**, as everything is interconnected – from the **economy to ecosystems, from industry to biodiversity**.

Cognitive Conclusion



*source SDG tiles: https://sdgs.un.org/goals

Source: FERI Cognitive Finance Institute / SNG, 2024

2 Biodiversity: The Relevance for Nature and People

Prof. Dr. Klement Tockner, Aidin Niamir

Biodiversity means the diversity of life – from the level of genetic composition to the level of ecosystem structure and function. It encompasses and integrates the global pool of information and knowledge generated and accumulated over more than 3.7 billion years of natural evolution. This unrivalled **"library of nature**" provides essential goods and services to sustain ecosystems, support human well-being and foster innovation and creativity.

Without the full range of genes, species, ecosystems, and associated functions and services we cannot have a healthy planet on which we fundamentally depend.

- How many species are there on Earth? If we exclude most of the microbial world the global number is estimated to be around 8 million species.[3]
- For comparison: the number of different bacteria has even been estimated to be as high as 1.75 billion.
- About 80 % of the 8 million species are still undiscovered. In the deep sea or in remote tropical forests, more than 90 % of the expected species are still unknown. Each year about 10,000 new species are described, while as many as 58,000 species become extinct at the same time. This means that we are losing a large proportion of the species pool before we even discover them.[4]

In this **video** David Attenborough provides further insights on the importance of biodiversity.

Even in low-diversity countries such as Germany, there are large gaps in the documentation and discovery of biodiversity. At least 30 % of the expected species, excluding megadiverse groups such as bacteria, archaea and protists, are not yet known – in one of the best-researched countries in the world. The proportion of "dark" biodiversity is particularly high in groundwater, soil, coastal sediments, and forest canopy.

- Biodiversity is the basis for ecosystem services and human well-being.
- Rapid biodiversity loss and climate change pose **immediate threats to human health and well-being**.
- We are on course to increase global air temperature by 3°C and to **lose 2 million species**, with unimaginable consequences for nature and future human generations.
- At the same time, we still remain optimistic that humanity can bend the biodiversity and climate curve.
  - **However, it will take bold, immediate, and concerted steps by society, politics, and economy to correct the unsustainable path we are on**.[5]

Biodiversity comprises three levels of increasing complexity**: genetic diversity, species diversity, the diversity of ecosystems.**

Planetary boundaries are a framework to define safe operating limits for human activity within Earth's environmental capacity. They represent thresholds for key Earth system processes, aiming to prevent irreversible environmental damage. There are nine boundaries covering areas like climate change and biodiversity loss, crucial for maintaining a stable environment for humanity.

[3] IPBES (2019, Global Assessment Report).

[4] IPBES (2019, Global Assessment Report).

[5] Rockström et al. (2021, Identifying Corridor).

While exploring the significance of biodiversity for both humanity and the planet, it is crucial to consider the broader context of planetary boundaries that provides a vital framework for assessing the extent of human impact on Earth's ecosystems.

Richardson et al. (2023) have identified **nine planetary boundaries**, representing critical thresholds for Earth's stability.[6] Alarmingly, **humanity has exceeded the safe operating space for six of these** boundaries. Among these is the planetary boundary for genetic diversity, defined as the maximum extinction rate compatible with preserving the genetic basis of the biosphere's ecological complexity.

This underscores the urgency of our efforts to address biodiversity loss and emphasizes the essential role of conservation in safeguarding the intricate web of life on Earth.[7]

These **insights** by Prof. Dr. Johan Rockström give an update on the risks of destabilizing the planet.

2.1. Biodiversity Values: The Importance of Nature for People

The benefits that people derive from nature and its biodiversity are called "ecosystem services" (ES), or nature´s contribution to people. The common categories of ES are:

- **regulating** (e.g., pest and disease control, water and air purification, climate regulation),
- **provisioning** (e.g., food, fibre, genetic resources, medicines),
- **supporting** (e.g., primary production, soil formation, nutrient cycling), and
- **cultural** (e.g., recreation, celebration of nature) services.[8]

According to the *Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)*,

- an estimated **4 billion people rely primarily on natural medicines**,
- up to 50 % of the medicines approved in the last 30 years are either directly or indirectly derived from natural products, and
- some **70 % of drugs used to treat cancer treatment are derived from or inspired by nature**.[9]
- More than 75 % of the world's food crop species depend on animal pollination, and
- marine and terrestrial ecosystems sequester around 60 % of global anthropogenic carbon emissions.

Monetary valuation of ES is still considered useful in communicating and in raising awareness of the magnitude of these services relative to other values. Total global ES have been estimated to be as high as USD 125 trillion per year (for the year 2011), although these values need to be treated with care.[10] At the same time, the loss of ES ranges from USD 4.3 to USD 20.2 trillion per year, mainly due to land-use changes. The average value per ecosystem type ranges from USD 490 per year and hectare (open ocean) to USD 350,000 per year and hectare (coral reef), with a high degree of variation within each ecosystem type.[11] However, most of these values are outside the private market and considered as non-tradable public goods.

- The "Beyond GDP" debate has become a key point to **change the perspective on economic growth** and put **ES at the core of the framework** – moving from human wealth to human well-being.[12]
- Indeed, the ES concept has become an effective bridge between ecological and economic approaches.
- ES and the natural capital need to be integrated into mainstream economic policy and the public discourse.

6 Richardson et al. (2023, Planetary Boundaries).
7 Stockholm Resilience Centre (2024, Planetary Boundaries).
8 Earthwise (2024, Ecosystem Services).
9 Newman et al. (2012, Natural Products).
10 Costanza et al. (2014, Value of Ecosystem Services).
11 Costanza et al. (2017, Ecosystem Services).
12 De Groot et al. (2012, Value of Ecosystems).

> *Healthy, species-rich and functional ecosystems make a major contribution to mitigate climate change. If we act quickly and thoughtfully, this will benefit sustainability in many ways.*
>
> Almut Arneth, Institute of Meteorology and Climate at the Karlsruhe Institute of technology (KIT)[13]

Maximising ecosystems for a single service, such as primary production, may have severe consequences and trade-offs for other services such as clean water, temperature buffering or recreation.

- ES are usually not fully replaceable, some are irreplaceable.
- The challenge is therefore to optimise the provision of a wide range of ES in decision-making from local to global scales.
- Moreover, the degradation of ecosystems and their services is primarily at the expense of the poor people and future generations, emphasizing the disproportionate impact on Most Affected People and Areas (MAPA).
  - This underscores the urgent need for concerted efforts to conserve biodiversity and mitigate its loss for the well-being of all, particularly the most vulnerable human populations. Europe e.g. exceeds biological capacity limits at the expense of other regions**.**

Another important role of biodiversity is to **stabilize ecosystem processes and the services** they provide for society, primarily due to the complementary or independent dynamics among populations, species and ecosystems. The so-called **"portfolio effect"** has been demonstrated for marine and inland fisheries.[14] For example, the number of populations and associated life history diversity of sockeye salmon (*Oncorhynchus nerka*) influences fisheries in Bristol Bay, Alaska.

- Heterogeneous landscapes safeguard biodiversity and increase the **resilience** of ecosystems.
- Mixed forests can **store** about **three times more water and carbon** than single-species plantations.
- They also **buffer climate extremes**, are more resilient to environmental changes and provide fundamental cultural services such as recreation.

A recent European survey showed that there is a **clear positive correlation between bird diversity and human well-being**. In fact, there is a distinct correlation between bird richness and well-being. A 10 % increase in the number of birds in your neighbourhood may cause a similar effect on your well-being as a 10 % increase in your salary.[15] Hence, natural, and semi-natural ecosystems have a substantial role to play in health prevention and treatment that has yet to be exploited.

There is a close relationship between nature, its biodiversity, and human health. Well-known services include the provision of medicines (as mentioned above), healthy nutrition and food security, supply of clean water and air, or the removal of pollutants. Less well known are the **multifaceted consequences of biodiversity on physical, mental and social health**, including effects on infectious diseases, allergies, inflammation and the microbiome.

Three hypotheses explain the **nexus biodiversity-human health**:[16]

1. The **"biophilia hypothesis"** proposes that humans have an intrinsic affinity for nature and biodiversity due to the co-evolution of humans and nature.
2. The **"biodiversity hypothesis"** proposes that exposure to biodiversity improves the immune system by regulating the human microbiome.
3. The **"dilution effect hypothesis"** proposes that high vertebrate species richness reduces the risk of human infectious disease by diluting pathogens across species.[17]

[13] Helmholtz-Klima-Initiative (2022, Biodiversität Klimaschutz).

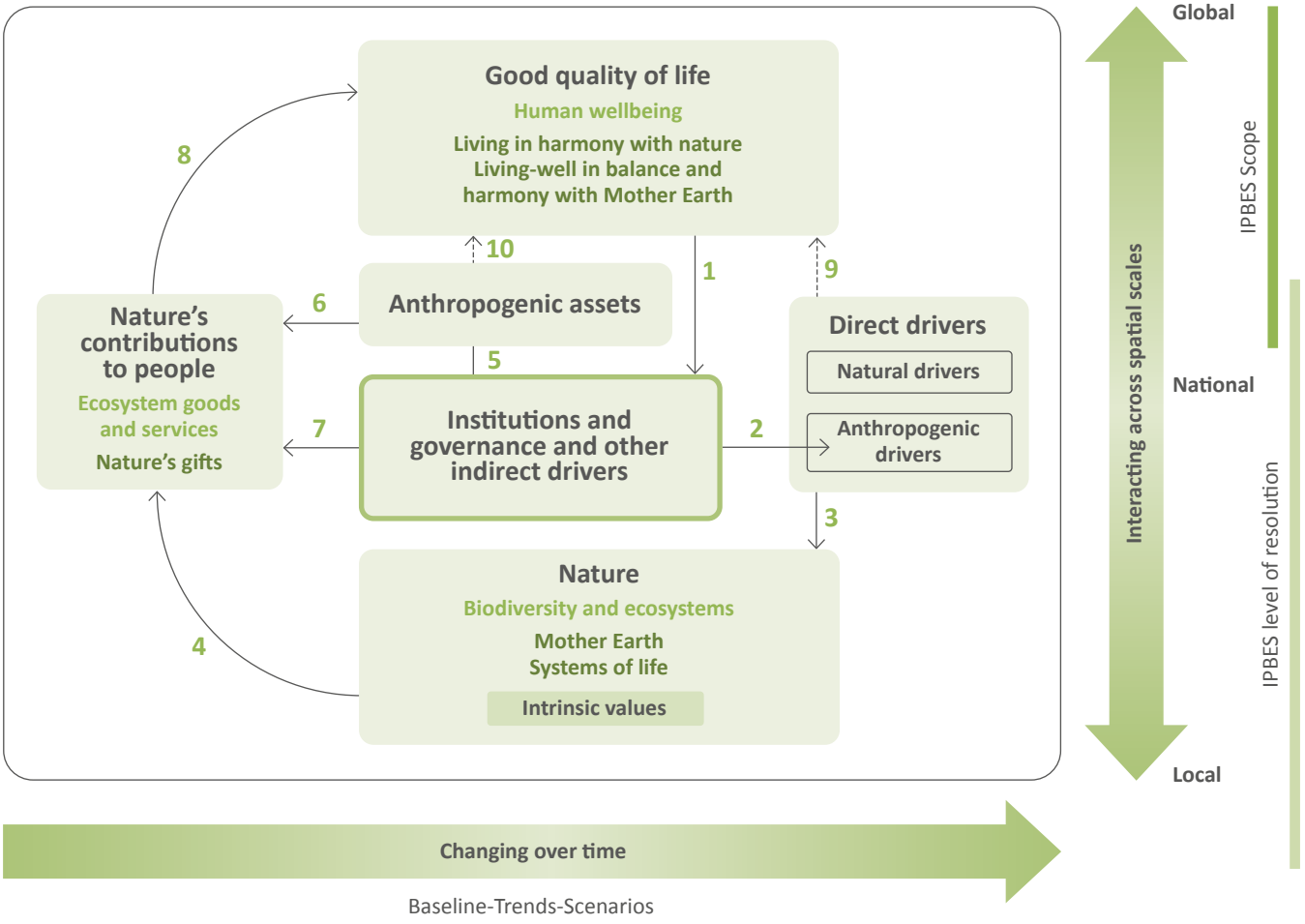
[14] Schindler et al. (2010, Portfolio Effect).

[15] Methorst et al. (2021, Human Well-Being).

[16] Sandifer et al. (2015, Biodiversity and Human Health).

[17] Aerts et al. (2018, Positive Health Effects).

Figure 1: The IPBES Conceptual Framework



Source: IPBES (2019, Global Assessment Report) [18]

Indeed, human health could be a key (indirect) motivation in biodiversity conservation, mitigating climate change, and thus "bending the curve". However, there is also a need to reallocate resources in the health care system, with a much higher share going to preventive measures than is currently the case. In Germany, according to the *Federal Statistical Office*, health expenditure exceeded EUR 474 billion in 2021, corresponding to 13.2 % of total GDP. Less than 6 % of these resources are used for prevention and precaution.

- A key challenge in integrating biodiversity with human health and well-being is the fundamental **differences in approaches**, methods, and concepts between the two disciplines.
- At the same time, there are limited long-term studies with a sufficient replication to investigate the underlying mechanisms of these linkages.
- Other challenges include the **complexity and uncertainty of the relationship** between biodiversity and human health, the individual contexts, scale effects, path dependencies, and the ongoing challenge of separating correlation from causation.
- This is evident in investigating the relationship between biodiversity and infectious diseases, where we need to separate proven facts from simple observations.

[18] IPBES (2019, Global Assessment Report).

Regulating ES are important for the containment of diseases and pandemics: A recent example highlighting the relationship between human health and biodiversity is the **COVID19 pandemic**.

The emergence and rapid spread of the SARS-CoV-2 virus, which caused COVID19, has been linked to human encroachment into natural habitats and wildlife trade. As humans continue to alter ecosystems, disrupt natural habitats, and get into closer contact with wildlife, the risk of zoonotic diseases spilling over into human populations increases.

Biodiversity loss and habitat destruction can lead to the fragmentation of ecosystems, facilitating the transmission of diseases from animals to humans. This pandemic underscores the critical importance of preserving biodiversity and maintaining healthy ecosystems for human health and well-being.

Biodiversity and food security are another key nexus. Pironon et al. (2024) assessed the global distribution of plant species used by humans (a total of 35,687 species; less than 10 % of all described plant species) for various reasons such as food, medicine, or material.[19] They found a high concordance between used and total plant diversity, highlighting the importance to protecting biodiversity while supporting people. However, the threat posed by biodiversity loss becomes even more pronounced when considering insect mortality and the decline in food crop diversity. This combination poses a significant risk, potentially resulting in annual global crop losses valued at USD 235-577 billion.

About 6,000 plant species are used as a source of human food but just 4 species – wheat, rice, maize and soybeans – provide more than 60 % of all the calories consumed by the world's population.

Increasing crop diversity by alternating crops over time in rotations, diversifying agricultural landscapes, or using of pest-repellent crops **may increase agricultural production** and interannual reliability. Biodiversification of agriculture therefore has the potential to provide benefits for both human health and ecosystem functions and services, as well as to make agriculture more resilient against climate change.[20]

2.2. Biodiversity and Climate: Two Facets of the Same Coin

According to the *Global Risks Report 2024* of the *World Economic Forum,*[21] the most pressing risks over the next 10 years are environmental risks related to climate change, biodiversity loss and the collapse of entire ecosystems.

- Environmental risks will continue to dominate the risk landscape.
- However, many economies remain largely unprepared for non-linear change and the crossing of environmental and socioeconomic tipping points.

In Earth system research, a ***tipping element*** is a large-scale component of the climate or, more generally, the Earth system that can be shifted into a new state by even minor external influences when it has reached a "tipping point".

Until most recently the global crises of climate change and biodiversity loss have been addressed separately. Pörtner et al. (2023)[22] state that these crises will not be successfully resolved unless both are tackled together.

Indeed, climate change is a key driver of biodiversity loss, while effective conservation of biodiversity will support climate change mitigation and adaptation and hence human well-being.

- Failure to act will increase poverty, decrease food security, foster human displacement, and magnify political instability.

[19] Pironon et al. (2024, Global Distribution of Plants).

[20] Muller et al. (2017, Organic Agriculture).

[21] WEF (2024, Global Risk Report).

[22] Pörtner et al. (2023, Climate and Biodiversity).

- Only by addressing both crises (climate change and biodiversity loss) together we can achieve a safe and equitable pathway for our planet and humanity.

It is therefore surprising that these interlinked crises are not adequately considered, as both crises reduce nature´s contribution to human well-being.

- When entire ecosystems are transformed toward low-biodiversity habitats, their capacity to absorb pollution, store carbon, retain water or regulate temperature is often degraded too.
- At the same time, environmental stressors such as drought or pollution, reduce the capacity of ecosystems to perform their natural functions and services, which in turn can create feedback loops that further accelerate climate change and biodiversity loss.

Consequently, greater biodiversity means higher resilience to climate change and other perturbations, which is known as the **portfolio effect** of biodiversity.[23] Human health and well-being must be at the centre of landscape and urban planning, in particular when considering the coupled effects of biodiversity and climate.

- **Climate change** is an increasingly **major driver of biodiversity loss**, causing the reduction of suitable habitats, leading to range shifts and displacements of species, and exceeding tolerance and adaptation limits of species.
- At the same time, **ecosystem degradation** such as deforestation, peatland drainage, urbanisation or pollution, may lead to a reduction of carbon stocks and **reduce thermal buffer effects**.

Measures to combat climate change may have adverse effects on biodiversity and ecosystem functioning. A global boom in hydropower development may fragment the remaining free-flowing rivers, altering the flow, sediment, and thermal regimes of entire river networks, not only harming migratory fish species but also accelerating the collapse of river deltas.[24] [25]

- **Hydropower** is a renewable energy source, but it is neither environmentally friendly nor climate-neutral. Reservoirs behind dams, in particular in the tropics and subtropics, are major emitters of greenhouse gases.
- Similarly, the conversion of ecosystems for **biomass production** can lead to landscape transformation and biodiversity loss.[26]

Restoring floodplains and peatlands can benefit both biodiversity and climate by increasing carbon storage, dampening droughts and floods, fostering natural ecosystem processes such as erosion and sedimentation, and supporting a unique biodiversity.

- **Indeed, we observe a paradigm shift in landscape hydrology: from draining to retaining water in the landscape**.

There is an increasing pressure to implement **geoengineering solutions** (e.g. manipulating the atmosphere), with unforeseen consequences for nature and humans alike. Humans have already carried out several global experiments such as heating the atmosphere, illuminating the night, changing the flow and sediment regime of large rivers, or alternating forests into cropland: The long-term consequences for nature and ecosystems are immense and often irreversible.

Geoengineering solutions are considered an option to mitigating Climate Change and Global Warming. Geoengineering approaches include Natural Climate Solutions (e.g., Ecosystem Restoration, Blue Carbon, etc.), Solar Radiation Management, Carbon Dioxide Removal and a diverse array of Climate Change mitigation and adaptation technologies. The implementation of geoengineering techniques may cause major albeit unpredictable impacts and risks on people and nature alike.

[23] Mahecha et al. (2022, Insurance Effect).

[24] Reid et al. (2019, Freshwater Biodiversity).

[25] Zarfl et al. (2015, Hydropower).

[26] Hof et al. (2018, Bioenergy).

2.3. Biodiversity Loss: The Global Erosion of Biodiversity

Nature and its biodiversity are being eroded at an unprecedented rate — and the rate of decline is accelerating, as:

75 % of the land surface has been altered by humans,
66 % of oceans experience cumulative impacts, and
85 % of wetlands have been drained.

- As a result, **species extinction rates are now at least 100 times higher than the historical baseline** (1850 is often used as a reference point).
- Species extinctions are irreversible over political timescales, and they are triggered by multiple human activities. The consequences of biodiversity loss are not fully understood and appreciated due to lag effects, interactions among multiple stressors, and non-linear changes.

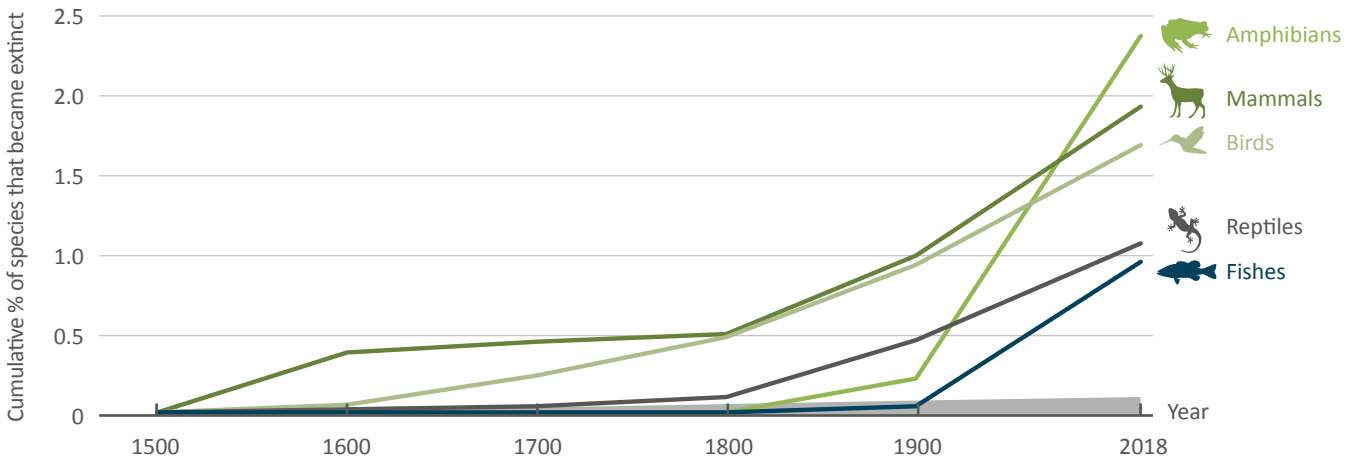
However, if we do not know the consequences of a 25 % or even higher decline of biodiversity we must be particularly cautious.[27] [28] [29] Furthermore, it is a myth that degraded ecosystems can be fully restored, while novel ecosystems are increasingly replacing natural ones.

This **video** concludes that humans would need five earths to maintain our current way of life.

In a recent study, Hochkirch et al. (2023) analysed the conservation status of about 15,000 species in Europe.[30] As a result, the number of species at risk of extinction is calculated to be twice as high as the previous *UN* estimates (*IPBES*).

- Globally, about 25 % of all predicted species, which corresponds to about 2 million species,[31] could become extinct by the end of this century.[32] In particular insects, which have not been very well documented to date, face a much higher risk than previously estimated.

Figure 2: Global Extinction Rate



Background rate (0.1-2 extinctions per million species per year)
Global extinction rate is at least tens to hundreds of times higher than it has been on average over the last 10 million years

Source: IPBES (2019, Global Assessment Report) [33]

[27] Isbell et al. (2011, Ecosystem Services).
[28] Isbell et al. (2015, Biodiversity).
[29] Reich et al. (2012, Biodiversity Loss).
[30] Hochkirch et al. (2023, Threats to Biodiversity).
[31] Hochkirch et al. (2023, Threats to Biodiversity).
[32] IPBES (2019, global assessment).
[33] IPBES (2019, Global Assessment Report).

Species diversity is often used as a synonym for biodiversity. However, **genetic variation** (i.e. diversity within species**) is fundamental to population fitness and adaptation to environmental change**. In contrast to species diversity, much less is known about the status and the rate of change of genetic diversity. Current rates of population extirpation are most likely orders-of-magnitude higher than species extinction rates. However, most conservation programmes focus on species diversity rather than on genetic (or ecosystem) diversity.

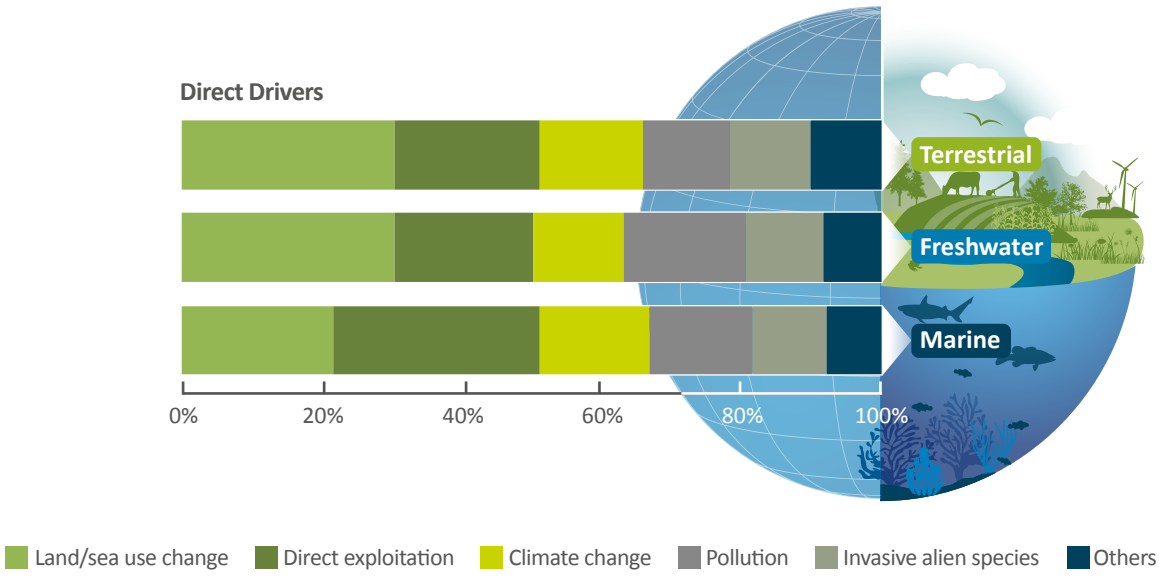
Leigh et al. (2019), based on a global meta-analysis, estimated an average 5.4 % - 6.5 % decline in within-population genetic diversity of wild organisms since the industrial revolution; on islands, however, the decline is as high as 27.6 %.[34] These are very conservative values because extinct species have not been included in the analysis and major biases exist across regions and taxonomic groups. More recently, Exposito-Alonso et al. (2022) estimated an average loss of genetic diversity of over 10 %, with rates very similar for threatened and non-threatened species, exceeding the *United Nations*' post-2020 targets for genetic conservation. [35]

In some cases, such as for freshwater megafauna, population declines exceed 90 % in just 40 years (i.e. between 1970 and 2010).[36] The loss of megafauna populations is leading to major decreases of multiple ecosystem services, with serious consequences for local human communities and indigenous people.

Genetic diversity of crop species is very critical for feeding more than 8 billion people in an era of rapid environmental change including global warming, land use change and pollution.[37] Despite remarkable efforts to prioritise and conserve crop diversity, the extent, drivers and significance of its loss remain poorly documented and understood.

The most widely quoted *Food and Agriculture Organization (FAO)* estimate is that **75 % of crop diversity disappeared during the 20th century.**[38] Today, 1,750 genebanks – excluding botanical gardens, universities and community seedbanks – preserve crop diversity worldwide, containing over 7 million samples.[39] [40]

Figure 3: Targets on Direct Drivers of Nature's Decline



Source: IPBES (2019, Global Assessment Report) [41]

[34] Leigh et al. (2019, Loss of Genetic Variation).
[35] Exposito-Alonso et al. (2022, Genetic Biodiversity Loss).
[36] He et al. (2019, Freshwater Megafauna).
[37] Renard et al. (2021, Food Security).
[38] Khoury et al. (2022, Loss of Crop Diversity).
[39] Breman et al. (2021, Plant Diversity).
[40] Mascher et al. (2019, Genebank).
[41] IPBES (2019, Global Assessment Report).

- The main direct drivers of biodiversity loss are land use change and degradation, direct **overexploitation (e.g., overfishing), pollution, climate change and invasive species** (see **Figure 3**).
- These drivers do not act in isolation, they **interact and cause additive, cumulative or synergistic effects o**n biodiversity and people alike, leading to non-linear changes and multiple feedback loops.
- In addition, **new pressures** such as light and noise pollution, microplastics, emerging contaminants, and **cumulative stressors have emerged** in the last decade(s).[42]

Agricultural land-use change is the main threat to biodiversity, in Europe and globally.
Detrimental subsidies (e.g. through the *Common Agricultural Policy (CAP)*), intensification and homogenisation of land use, high use of fertilisers and pesticides, and decreasing crop diversity are, among others, the key drivers of biodiversity loss. Unfortunately, the *European Green Deal* has not fulfilled its promises, and we observe a major setback in the implementation of nature-positive measures and the *Kunming-Montreal Global Biodiversity Framework Targets*. Indeed, we are facing an irresponsible development for both nature and people.

Biological invasions, for example, are responsible for biodiversity declines as well as high economic costs to society. Worldwide, more than 37,000 alien species are established, of which about 10 % are considered invasive. These invasive species have contributed to about 60 % of global species extinctions; on islands 90 % of species extinctions are attributed to invasion.[43]

Global mean annual economic costs have been calculated to reach USD 423 billion (year 2019), mainly through the damage to nature´s contributions to human well-being. Water hyacinth (*Pontederia crassipes*), red imported fire ant (*Solenopsis invicta*) and zebra mussel (*Dreissena polymorpha*) are invasive species with the greatest impact on nature´s contribution to people.[44] Today, 156 countries have action plans to manage biological invasions, with varying degrees of success.

2.4. Biodiversity Protection: What It Will Take to End Mass Extinction

Increased efforts are urgently needed to prevent further loss of biodiversity and the ecosystem services that it provides. Ambitious targets have been proposed, such as the *Sustainable Development Goals (SDGs),* the *Aichi Biodiversity Targets*, and more recently the *Kunming-Montreal Global Biodiversity Framework Targets;* almost none of the previous targets have been met so far. For example, many of the *Aichi targets* did not commit countries to specific actions. Therefore, it is not surprising that at the global level none of the 20 targets have been met or achieved, although progress has been made at the level of some countries.

There is **no alternative to increasing** and strengthening conservation **measures** and restoring degraded systems. Moreover, reduced food waste, a more plant-based human diet, and a sustainable trade, and agricultural intensification may avoid two thirds of future biodiversity loss.[45] This includes **tackling the drivers of land-use change**. Bending the curve is technically possible and economically feasible but would require concerted leadership to design and implement adequate policies.

*Further insights on the key impact areas and key parameters for **"Alternative Food Systems"** in the study by FERI Cognitive Finance Institute.*

Currently, about 17 % of the Earth´s land surface (including freshwaters) and 10 % of the oceans are protected; however protected areas are often so-called "paper parks" that are not effectively managed, with pressures on biodiversity shifting to areas outside of the protected areas. At the same time, biodiversity in protected areas may be declining as fast as outside of them because many pressures such as climate change and pollution, do not respect boundaries; concurrently, protected areas are often too small to achieve their purpose, and the implementation of conservation measures is at least inadequate.[46]

[42] Reid et al. (2019, Freshwater Biodiversity).
[43] Roy et al. (2023, Invasive Species).
[44] Roy et al. (2023, Invasive Species).
[45] Leclère et al. (2020, Bending The Curve).
[46] Gatiso et al. (2022, Protected Areas).

*The joint study **"Sustainable Blue Economy"** by FERI Cognitive Finance Institute, GEOMAR and Fraunhofer takes further insight on the oceans economic potential.*

- We will need a **continuum of protection requirements** from pristine to sustainably managed to novel ecosystems.
- We also need to **focus on the multifunctionality of ecosystems** through a mix of conservation and restoration measures.
- **Biodiversity offsets need to be considered carefully**, as restoration or protection elsewhere may not compensate for the loss of certain systems.

The recently established ***Global Biodiversity Framework Fund (GBFF)*** aims to support countries to slow, or halt, the loss of biodiversity. However, recent work has shown that up to **USD 967 billion a year is needed** to achieve these targets.[47] The USD 219 million pledged by the first five countries to the *GBFF* is therefore a drop in the ocean. Philanthropic foundations are a growing source of funding for biodiversity conservation and restoration.

Recognising and respecting the rights of indigenous peoples and local communities will play a fundamental role in the successful implementation of the *GBF*. Therefore, a careful balance between strictly protected areas and areas that are sustainably used by humans is required to preserve both our biological and cultural heritage.

Dasgupta & Levin (2023) emphasise that **contemporary economic thinking does not acknowledge that the economy is embedded in nature**. In contrast, economics treats humanity as a consumer of nature. Therefore, they emphasise the concept of **"*inclusive wealth*"** to manage global public goods such as tropical forests, the atmosphere and the open ocean in a sustainable way.

Globally, **produced capital** *per capita* doubled in size in the period 1992-2014, **human capital** *per capita* **increased by about 15 %,** while **natural capital** *per capita* **declined by 40 %**.[48] In effect, **we are exploiting Nature´s services** without paying for them, such as fishing in the open and deep sea or storing carbon in the atmosphere. Dasgupta & Levin (2023) give three examples why our use of the biosphere amounts from plundering Nature:

- environmental subsidies,
- common goods, and
- trade and wealth transfer.

For example, the aggregate subsidy that humanity pays itself to "mine" Nature is in the order of USD 4-6 trillion per year (5-7 % of global GDP), putting enormous pressure on biodiversity. Removing, or redistributing these subsidies would shift consumption away from nature-intensive goods and could support a nature-positive society.

In Germany about EUR 83 billion are invested annually in environmental protection.[49] However, 94 % of this money is spent on wastewater treatment, waste management and the removal of environmental damages.

We need to **overcome** the "**impair-then-repair**" paradigm, which remains the guiding principle in our relationship with nature. This means that we must strongly increase the proportion of resources devoted to prevention and conservation strategies, rather than focusing on "clean-up" activities.

Inclusive wealth is the **aggregate value of all capital assets** in a certain region, including human capital, social capital, public capital, and natural capital. Maximizing inclusive wealth is a goal of sustainable development.

[47] Karolyi et al. (2023, Biodiversity Finance).

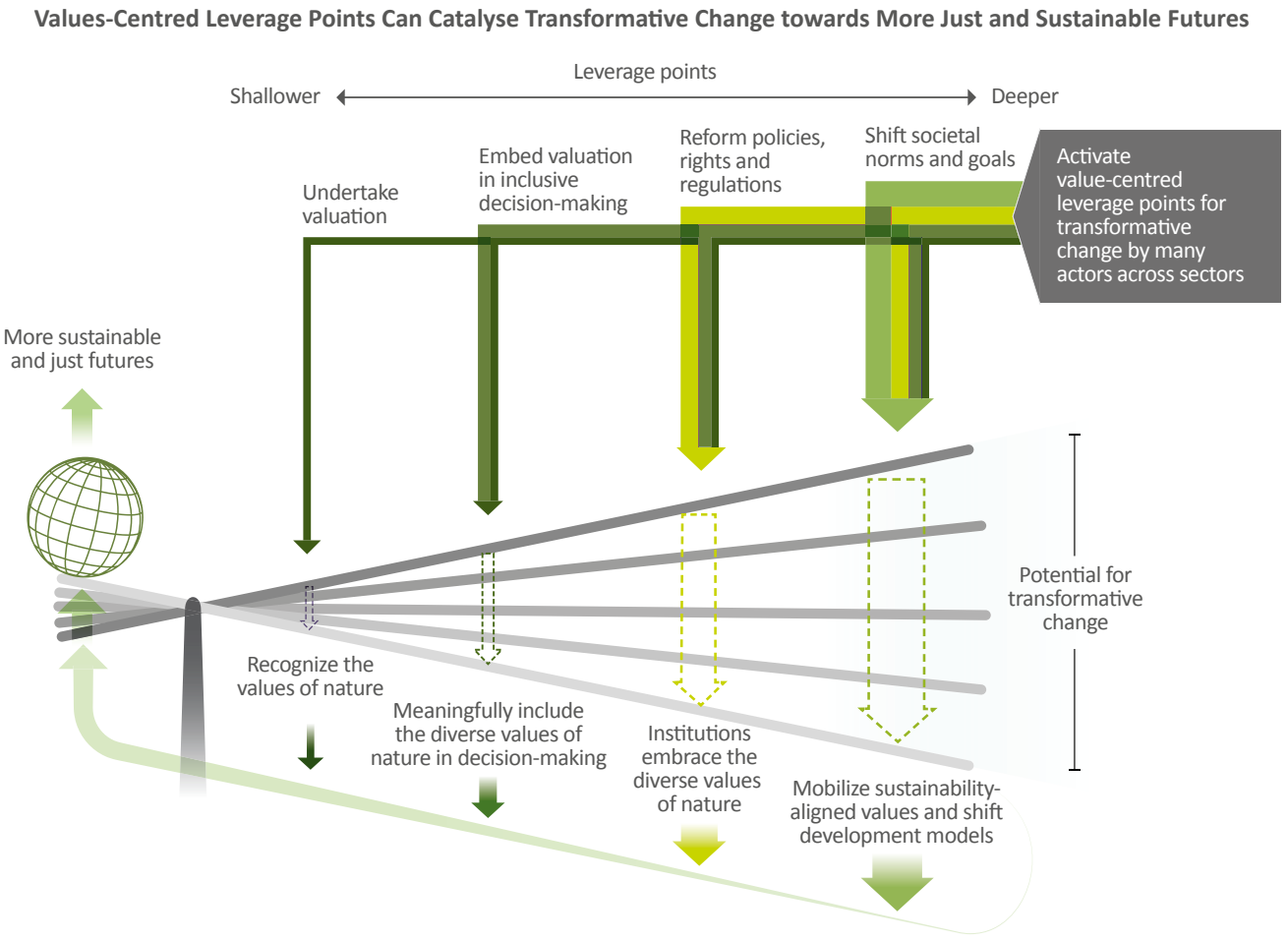
[48] Dasgupta et al. (2023, Economic Factors).

[49] Destatis (2024, Umweltschutzausgaben).

Nature-based solutions (NbS), including restoration and conservation measures, are some of the most effective and efficient ways to combat biodiversity decline and climate change, albeit major variations in their effects among regions and systems. At the same time, NbS are constrained by climate change. For example, rewetting of peatlands may be controlled by landscape hydrology because evaporation rates are increasing and precipitation regimes are shifting. Reducing greenhouse gas emissions and limiting global warming to below 1.5°C are of utmost importance, although 1.5°C already weakens the effects of NbS.

Nature-based solutions (NbS) are integrated approaches that address biodiversity conservation, climate change mitigation and adaptation as well as sustainable development objectives. They create important synergies between the three Rio Conventions and the Agenda 2030 with its Sustainable Development Goals (SDGs).

Figure 4: Diverse Values of Nature



Source: Pascual et al. (2023, Values of Nature) [50]

[50] Pascual et al. (2023, Values of Nature).

Ambitious biodiversity, climate, and sustainability goals are likely to fail unless we address the direct (and indirect) drivers of climate change and biodiversity loss more rigorously. In fact, there already is some progress in the implementation of the *Kunming-Montreal Global Biodiversity Framework*, including the necessary redirection and reduction of environmentally damaging subsidies, the expansion and proper management of protected areas, or the reduction of pesticides and fertilisers.

A fundamental question is **how to measure biodiversity** to identify causal relationships **between drivers and responses**.

- Species diversity remains a robust indicator to assess biodiversity.
- However, we also need to focus on genetic and functional diversity.
- We urgently need a robust biodiversity monitoring programme to detect changes in biodiversity of all components and spatially explicit.

The data revolution, i.e. the data availability and analysis of data due to advances in remote sensing technologies (e.g. *European Copernicus Earth Observation Programme*), molecular approaches (e.g. eDNA), citizen science and big data analysis (e.g. through AI applications), would make it possible to model and monitor changes in biodiversity, ecosystem functions and ES in a spatially explicit and quasi in real-time manner.

More information on the potential of the New Space Economy and the connection to climate protection through satellite data in the Cognitive Briefing: ***"New Space"****.*

"Desertification is a fancy word for land that is turning to desert, and this happens only when we create too much bare ground. There's no other cause. I intend to focus on most of the world's land that is turning to desert."

Allan Savory, Zimbabwean farmer and co-founder of Savory Institute
Clifford Allan Redin Savory (n.a., Grasslands)

3 Biodiversity Regulation: The Policy Landscape

Antje Biber, Dr. Tobias Raffel, Aidin Niamir

An evolving policy and legal framework has been created to address the challenge of biodiversity loss. It includes multilateral treaties as well as regional agreements and national legislation. This chapter explains the most important element of the global biodiversity policy landscape and describes what is particularly relevant to financial institutions.

3.1. Multilateral Treaty: Convention on Biological Diversity

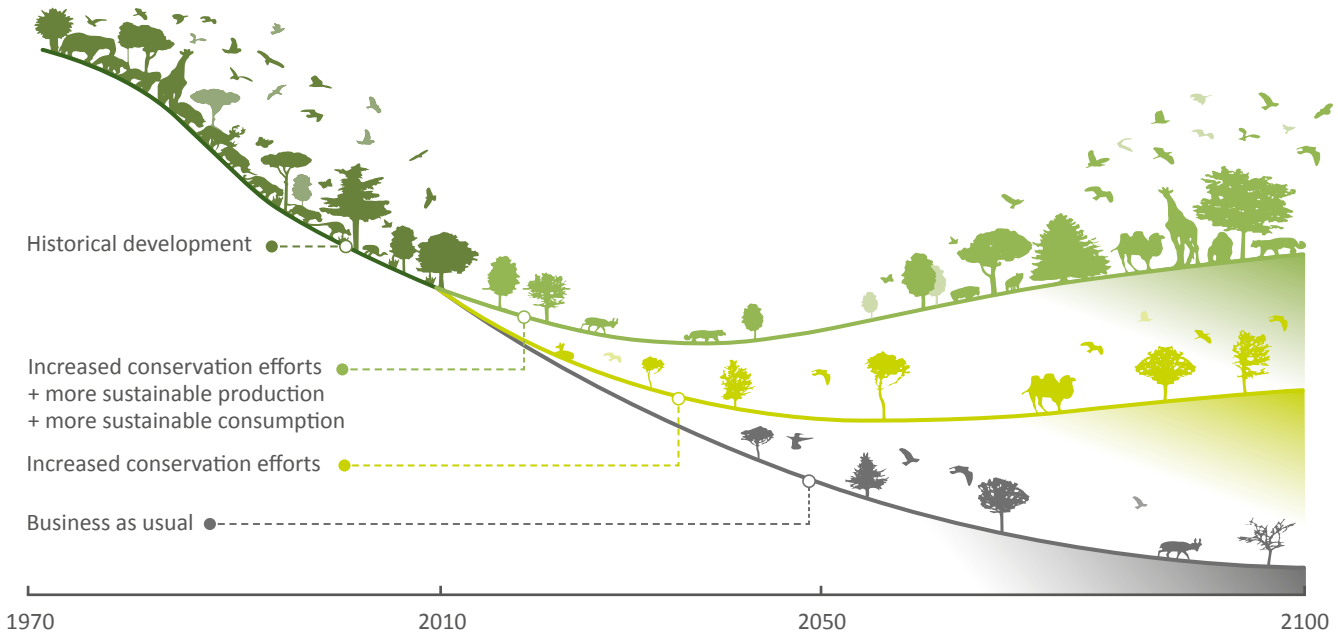
The *Convention on Biological Diversity (CBD),* also known as the *Biodiversity Convention*, is a *UN* treaty that was ratified by 196 states and came into force in 1993. The Convention has three main objectives:

- the conservation of biodiversity,
- the sustainable use of its components,
- and the fair and equitable sharing of the benefits arising from genetic resources.

Addressing these objectives together will be instrumental to "halt and reverse global biodiversity loss by 2030 and achieve full recovery by 2050" (see **Figure 5**).

In December 2022, and after a multi-year consultation and negotiation process, the *CBD* adopted the ***Kunming-Montreal Global Biodiversity Framework (GBF).***[51] The *GBF*, also known as the "*Montreal Agreement"*, is currently the most important international biodiversity agreement, and the "north star" for most nature conservation efforts. Highlighting its **landmark character**, it is often compared to the 2015 climate agreement signed in Paris which set the 1.5°C goal. Among the historic *GBF*'s key elements are 23 targets for 2030, agreements on resource mobilization, and a monitoring framework.

Figure 5: The Vision: Bending the Curve of Biodiversity Loss



Source: Leclère et al. (2020, Bending the Curve) [52]

[51] Convention on Biological Diversity (2022, Montreal Agreement).

[52] Leclère et al. (2020, Bending the Curve).

3.1.1. GBF Global Targets for 2030

The *GBF* has **23 action-oriented global targets** for urgent action over the decade to 2030. Actions to achieve these targets should be implemented consistently and in line with the *Convention on Biological Diversity* and its two Protocols, the *Nagoya Protocol on Access and Benefit-sharing of Genetic Resources*, and the *Cartagena Protocol on Biosafety*.

While the targets are interrelated and cannot be achieved in isolation, there are some specific targets that are directly **relevant to financial institutions**:

- **Target 14 (Integrate biodiversity in decision-making at every level)** aims to ensure that the values of biodiversity are fully reflected or mainstreamed in all relevant decision-making frameworks so that it is given proper attention in decision-making, leading to alignment of all activities, and of all financial flows, with the goals and targets of the *GBF*.
- **Target 15 (Businesses assess, disclose and reduce biodiversity-related risks and negative impacts)** aims to progressively reduce the negative impacts and increase the positive impacts of business on biodiversity and to promote more sustainable production patterns. To achieve this, countries should take steps to encourage and enable business and financial institutions to identify and disclose their dependencies and impacts on biodiversity. While this target applies to measures for all types of business, it places a particular emphasis on large and transnational companies and financial institutions. These types of companies and institutions often have large net impacts on biodiversity due to their size and scope of operations, supply and value chains, and portfolios.
- **Target 18 (Reduce harmful incentives by at least USD 500 billion per year and scale up positive incentives for biodiversity)** has two main components.
  - The first is the elimination, phasing out or reform of incentives, including subsidies, that are harmful to biodiversity.
  - The second is to scale up of positive incentives for the conservation and sustainable use of biodiversity. The target also identifies several action-oriented elements to achieve its objectives.
- **Target 19 (Mobilize USD 200 billion per year for biodiversity from all sources, including USD 30 billion through international finance)** focuses on increasing the amount of financial resources for the implementation of national biodiversity strategies and actions to USD 200 per year by 2030. To accomplish this, the target sets a number of distinct elements such as international financial resources, private sector finance, innovative finance schemes, as well as synergies with climate finance.

Together with the 4 goals for 2050, the 23 targets for 2030 form the so-called "Biodiversity Plan". The *Global Biodiversity Framework* is now branded under this name (**Figure 6**).

Figure 6: Montreal Agreement: The Biodiversity Plan

Source: Convention on Biological Diversity (2023, The Biodiversity Plan) [53]

[53] Convention on Biological Diversity (2023, The Biodiversity Plan).

3.1.2. GBF Resource Mobilization

The effective mobilisation of sufficient financial resources is crucial to the successful implementation of the *Global Biodiversity Framework.* This need is underlined in Target 19 and further elaborated out in the complementary decision on resource mobilization of the framework.[54] Recognising the urgent need to strengthen international financing for biodiversity, the *CBD* has requested the ***Global Environment Facility (GEF)*** to establish a special trust fund to support the implementation of the *GBF*, to complement existing support and to scale up financing to ensure its timely implementation, taking into account the need for adequacy, predictability, and timely flow of funds. A few months later the *GEF Assembly* ratified the establishment of the ***Global Biodiversity Framework Fund (GBFF)*** and its Programming Directions. The *GBFF* Programming Directions include the main themes of the *GBFF* project a consolidated set of criteria and requirements applicable to all *GBFF* projects.[55]

3.1.3. GBF Monitoring Framework

Monitoring progress towards the goals of the *GBF* requires a set of measures to assess progress towards desired objectives at different scales and to signal key issues that need to be addressed through policy interventions and other actions. Indicators are information tools that summarise data on diverse and complex environmental and socio-economic issues to show overall status and trends. The *GEF* is accompanied by a detailed monitoring framework consisting of a set of agreed indicators to track progress towards the framework's objectives. The **monitoring for the *Kunming-Montreal Global Biodiversity Framework*** *(GBF)* includes headline indicators recommended for national, regional, and global monitoring, as well as more detailed component and complementary indicators. At present, not all targets have an identified set of indicators, and this is a work in progress and requires a collective effort. **Table 1** summarises the current set of indicators to the relevant to financial institutions.[56] Further development of the monitoring framework is on the agenda for further discussion and review at the 16th Conference of the Parties to the *Convention on Biological Diversity (CBD* COP16) in Cali, Colombia, in October/November 2024.

Table 1: GBF Target and Indicators Relevant to Financial Institutions

	Headline Indicators:	Component Indicators	Complementary Indicators
Target 14		– Number of countries with implementation of the System of Environmental Economic Accounting	– Human Appropriation of Net Primary Production (HANPP) – CO_2 emission per unit of value added – Change in water-use efficiency over time
Target 15	– Number of companies reporting on disclosures of risks, dependencies and impacts on biodiversity	– Indicator based on Task Force for Nature-related Financial Disclosures	– Species threat abatement and restoration metric – Number of companies publishing sustainability reports
Target 18	– Positive incentives in place to promote biodiversity conservation and sustainable use – Value of subsidies and other incentives harmful to biodiversity that have been eliminated, phased out or reformed	– Value of subsidies and other incentives harmful to biodiversity, that are redirected, repurposed or eliminated	– Number of countries with biodiversity-relevant taxes – Number of countries with biodiversity-relevant charges and fees – Number of countries with biodiversity-relevant tradable permit schemes – Trends in potentially environmentally harmful elements of government support to agriculture (producer support estimate) – Trends in the number and value of government fossil fuel support measures – Amount of fossil-fuel subsidies per unit of GDP (production and consumption)

[54] Convention on Biological Diversity (2022, Resource Mobilization).

[55] Global Environment Facility (2024, GBFF).

[56] Convention on Biological Diversity (2023, Monitoring Framework).

	Headline Indicators:	Component Indicators	Complementary Indicators
Target 19	– International public funding, including official development assistance for conservation and sustainable use of biodiversity and ecosystems – Domestic public funding of conservation and sustainable use of biodiversity and ecosystems – Private funding (domestic and international) of conservation and sustainable use of biodiversity and ecosystems		– Amount of funding provided through the Global Environment Facility and allocated to the biodiversity focal area – Foreign direct investment, official development assistance and South-South cooperation as a proportion of total domestic budget – Amount and composition of biodiversity-related finance reported to the OECD Creditor reporting system – Dollar value of financial and technical assistance (including through North-South, South-South and triangular cooperation) committed to developing countries – Dollar value of all resources made available to strengthen statistical capacity in developing countries – Amount of biodiversity-related philanthropic funding – Proportion of total research budget allocated to research in the field of marine technology – Total amount of approved funding for developing countries to promote the development, transfer, dissemination and diffusion of environmentally sound technologies – Number of countries (and number of instruments) with payments for ecosystem services programs

Source: Convention on Biological Diversity (2023, Monitoring Framework)

To be effective, the above framework needs to be integrated into national and regional legislation. This integration is currently taking place in two ways:

- First, countries must develop ***National Biodiversity Strategies and Action Plans (NBSAPs)***.
- Secondly, countries are required to prepare **national reports** on the status of implementation of the *GBF*. Both will be discussed at *CBD* COP16.

The implementation of the *GBF* is likely to have several effects in the medium term, including:

- **New regulation of business** – among other things, companies will be required to disclose their impact on biodiversity.
- **More nature-friendly financial flows** – subsidies that encourage the destruction of nature will be reduced, and financial institutions will increasingly invest in nature.
- **Greater interest in the topic** – stakeholders will become more informed, articulate their positions more strongly and demand action.
- **Broader mandates of supervisory bodies** – central banks and their governing institutions will address the risks arising from the loss of nature.
- **International harmonization** – nature conservation policies will be more aligned.

3.2. European Regulation: From Political Goals to Implementation

The European Union is a **global frontrunner** when it comes to biodiversity ambition and regulation, despite the increasing headwinds for sustainability measures and narratives, and party-political instrumentalization of nature issues in recent times.

Three initiatives highlight the European efforts to set political goals in the field of nature and biodiversity and translate them to legal requirements for companies and the financial sector:

1. the *European Green Deal*
2. the *EU Biodiversity Strategy*
3. the *EU Nature Restoration Law*

3.2.1. European Green Deal

The *European Green Deal* is the EU's extensive strategy that aims to make its economy sustainable.[57] Together, the 27 member states want to **achieve net zero greenhouse gas emissions by 2050**, **decouple economic growth from resource use** and **leave no person or place behind**.

Key objectives include promoting the efficient use of resources through the transition to a clean and circular economy, restoring biodiversity and reducing pollution.

The *European Green Deal,* approved in 2020, comprises laws and action plans for all sectors of the economy. The most important of these are:

- ***European Climate Law*:** Targets net zero greenhouse gas emissions by 2050.
- ***EU Taxonomy*:** Classification system for defining sustainable economic activities.
- ***Biodiversity Strategy for 2030*:** The aim is to restore natural habitats and ecosystems.
- ***Farm to Fork Strategy*:** Focuses on sustainable food systems.
- ***Circular Economy Action Plan*:** Minimizes waste and promotes sustainability.
- ***Zero Pollution Action Plan*:** Reduces air, water, and soil pollution.
- ***Renovation Wave:*** Increases energy efficiency in buildings.
- ***Sustainable and Intelligent Mobility*:** The aim is to reduce transport emissions.

In the context of biodiversity, the most crucial elements of the *European Green Deal* are the ***Biodiversity Strategy*** for 2030, the ***Farm to Fork Strategy*** and the strategies surrounding sustainable use of land and marine resources. These components specifically target the restoration and protection of natural habitats, sustainable farming and fishing practices and the reduction of pollution, all of which are vital for preserving biodiversity.

3.2.2. EU Biodiversity Strategy

The *EU Biodiversity Strategy* for 2030 is part of the *European Green Deal* and focuses on protecting nature and reversing the degradation of ecosystems. It was published in 2020 and contains over 100 specific actions and commitments to be delivered by 2030.[58]

Key targets of the *EU Biodiversity Strategy* include:

- **Protecting at least 30 % of the EU's land and sea areas**, e.g. by expanding the Natura 2000 network of nature protection areas, currently covering 18 % of EU land area and 7 % of *EU* marine area.
- **Restoring degraded ecosystems across the EU** – The *EU Nature Restoration Law* was developed for this purpose (see next paragraph).
- **Enabling at least 25 % of agricultural land for organic farming.**
- **Planting three billion additional trees by 2030.**
- **Integrating biodiversity objectives into all EU policies.**

A significant amount of EU money is allocated to biodiversity action: According to the *European Commission*[59], the EU aims to use 7.5 % (2024) and 10 % (from 2026) of its budget for biodiversity objectives. At least **EUR 20 billion a year** should be unlocked for spending on nature through private and public funding at national and EU level. Also, a significant proportion of the EU budget that is dedicated to climate change will be invested in biodiversity and nature-based solutions to increase synergies between climate and biodiversity.

[57] European Council (2020, Green Deal).

[58] European Commission (2024, Actions Tracker).

[59] European Commission (2024, Biodiversity Financing).

3.2.3. EU Nature Restoration Law

The latest and heavily contested addition to European biodiversity regulation is the *EU Nature Restoration Law*. After extensive negotiations and compromises removing rules that critics argued would trouble farmers, the law is expected to come into force in 2024.

The legislation will force EU countries to **restore at least 20 % of land and marine areas in the EU by 2030**.[60] It contains binding targets for the restoration of at least 30 % of degraded habitats by then, rising to 60 % by 2040 and 90 % by 2050. Currently, more than 80 % of habitats in Europe – from forests, grasslands and wetlands to rivers, lakes, and coral beds – are in poor shape and need to be restored.

The law is praised by many experts as the **first continent-wide, comprehensive legislation of its kind**. Supporters argue that it will significantly improve a wide range of ecosystems both inside and outside protected areas. However, others point out that the restoration of ecosystems on 20 % of the total area still falls short of the 30 % target agreed by the global community in Montreal.

- All the aforementioned policy objectives and regulations (will) have a **significant impact on business,** as they oblige or encourage companies and the financial sector to adopt certain practices.
- Generally speaking, biodiversity regulation will **push market players** to integrate biodiversity consideration into risk management and investment decisions.

More concretely, biodiversity is now an integral part of most **European sustainability legislation** that companies and financial actors must follow, including in the following fields:

- **Classification**: To comply with the ***EU Taxonomy*** and the ***Sustainable Finance Disclosure Regulation*** *(SFDR)*, companies must classify their economic activities according to environmentally sustainable criteria and disclose their sustainability risks, impacts and performance. They should demonstrate how their activities contribute to environmental objectives without causing significant harm and make the sustainability characteristics of their financial products transparent. This process includes detailed assessment, documentation and reporting of sustainability-related information.
- **Due Diligence**: To comply with the ***EU Deforestation Law*** and the ***Corporate Sustainability Due Diligence Directive*** *(CSDDD)*, companies must establish and implement due diligence processes to ensure that their supply chains do not contribute to deforestation or human rights abuses. They must identify, assess, and mitigate risks related to deforestation and human rights in their global supply chains and document and report their efforts and results in accordance with the relevant regulations.
- **Reporting**: The ***Corporate Sustainability Reporting Directive*** *(CSRD)* requires companies to report on biodiversity in accordance with the *European Sustainability Reporting Standards (ESRS)* E4, which relate to biodiversity and ecosystems. This requires companies to assess and disclose their impacts on biodiversity and align their business operations and strategies with the objectives of protecting and restoring biodiversity. What must be reported in detail depends on the company's activities and their impact on biodiversity.
- **Communication**: To comply with the proposed ***EU Green Claims Directive***, companies will need to substantiate the voluntary environmental claims they make in business-to-consumer commercial practices. This requires backing up claims with life cycle assessments, communicating claims accurately and comprehensively and have them externally verified.

In addition to the many directives that apply to both companies and financial institutions, there is specific regulation for financial institutions. The next section will focus on what's most relevant for the financial sector.

3.3. Financial Regulation: Making Biodiversity Mandatory

For financial institutions operating in the EU, biodiversity has become a mandatory topic for analysis, reporting and disclosure. As mentioned above three regulatory requirements are particularly relevant: the *Corporate Sustainability Reporting Directive (CSRD),* the *EU Taxonomy*, and the *Sustainable Finance Disclosure Regulation (SFDR).*

[60] European Commission (2024, Nature Restoration Law).

3.3.1. Corporate Sustainability Reporting Directive (CSRD)

The *Corporate Sustainability Reporting Directive (CSRD)* aims to put sustainability reporting on par with financial reporting and makes biodiversity reporting mandatory. It requires companies to report on the risks and dependencies of the company in relation to biodiversity and ecosystems (outside-in perspective), as well as the impact of the company on biodiversity and ecosystems (inside-out perspective).[61]

Specific reporting requirements are described in the *CSRD's* ***European Sustainability Reporting Standards (ESRS)***[62] for a total of five subject areas, including biodiversity:

- **ESRS-E1:** Climate change mitigation and adaptation measures.
- **ESRS-E2:** Pollution prevention and control strategies.
- **ESRS-E3:** Sustainable use and protection of water and marine resources.
- **ESRS-E4:** Impact and dependencies on biodiversity and ecosystems.
- **ESRS-E5:** Transition to a circular economy and waste management practices.

The directive affects around 50,000 companies throughout the EU, 15,000 of which are in Germany. Companies meeting two of the following three conditions will have to comply with the *CSRD*: EUR 50 million in net turnover, EUR 25 million in assets, and 250 or more employees. In addition, non-EU companies that have a turnover of above EUR 150 million in the EU will also have to comply.

If the topic of biodiversity is material to the company's business model, the reporting obligation already applies today: companies that have already prepared a non-financial report in accordance with the *Non-Financial Reporting Directive (NFRD),* which generally includes large, listed companies as well as financial institutions, must report from 2025 for the 2024 financial year. Further groups of companies will be added in the years 2025-27.

3.3.2. EU Taxonomy

The *EU Taxonomy* is a **classification system** established to clarify which economic activities are environmentally sustainable. The aim is to prevent greenwashing and steer investment towards sustainable projects and companies. It was enforced in 2022 and applies to large companies (over 500 employees) under the *Non-Financial Reporting Directive (NFRD),* financial market participants offering products in the EU, and the EU and its member states when setting measures for green financial products.

The six environmental objectives of the *EU Taxonomy* are:

- **Climate Change Mitigation:** Reducing greenhouse gas emissions.
- **Climate Change Adaptation:** Increasing resilience to climate change effects.
- **Sustainable Use and Protection of Water and Marine Resources:** Preserving water bodies and marine life.
- **Transition to a Circular Economy:** Enhancing waste reduction and resource recycling.
- **Pollution Prevention and Control:** Reducing pollution to air, water, and soil.
- **Protection and Restoration of Biodiversity and Ecosystems:** Conserving natural habitats and species.

To comply with the taxonomy, an economic activity must make a significant contribution to one of the environmental objectives and should not cause significant harm to the other five environmental objectives. The disclosure should be included in non-financial reporting, either within annual reports or in dedicated sustainability reports.

The drafting of the *EU Taxonomy* faced intense debates, particularly regarding the inclusion of specific energy sources like **nuclear and natural gas** under sustainable activities. Nuclear and natural gas were finally included under specific conditions, classified as "transitional" activities. This classification means they are not yet replaceable by low-carbon alternatives but contribute to climate change mitigation and the transition to a climate-neutral economy.

[61] European Commission (2024, CSRD).

[62] EFRAG (2024, Reporting Standard ESRS-E4).

EU Taxonomy – Technical Screening Criteria[63]

Technical Screening Criteria (TSC) in the EU Taxonomy define which economic activities can be considered environmentally sustainable. Investors are required to assess and disclose the extent to which their investments align with these criteria, integrate the assessment into their investment strategies and report on their compliance with the taxonomy. Below are examples of technical screening criteria for the environmental objectives 3-6.

Objective 3: Sustainable Use and Protection of Water and Marine Resources

- Restoration and remediation of water and marine resources: e.g. the decontamination and/or remediation of soils and groundwater in polluted areas, and of surface water and its shores following accidental pollution.
- Water supply: e.g. the construction and operation of a new water supply system or an extension of an existing water supply system to provide water supply for new areas.
- Sewerage: e.g. urban wastewater treatment, phosphorous recovery from wastewater, production of alternative water resources, and sustainable urban drainage systems.

Objective 4: Transition to a Circular Economy

- Waste Management: e.g. the material recovery of secondary raw materials to substitute virgin materials or chemicals in production processes.
- Manufacturing of food products and beverages: e.g. design for reuse and recycling of packaging in practice.
- Manufacturing and sale of footwear and leather goods: e.g. spare parts should be available to customers for a period of at least 4 years from the date of purchase of the new product.

Objective 5: Pollution Prevention and Control

- Restoration and Remediation: e.g. cleaning up oil spills and other pollution in terrestrial ecosystems, soil, buildings.
- Waste management: e.g. the treatment and disposal of radioactive nuclear waste, disposal operations.
- Depollution and dismantling of end-of-life products: e.g. the dismantling of end-of-life products and movable assets and their components of any type (e.g., ships, computers, components from wind turbines) for material recovery.

Objective 6: Protection and Restoration of Biodiversity and Ecosystems

- Farming: e.g. agriculture should maintain or improve biodiversity via grazing in habitats where it is beneficial for biodiversity.
- Manufacturing: e.g. the selection of ingredients for food and beverage products should be sourced in a way that improves biodiversity and ecosystem health.
- Restoration of biodiversity and ecosystems: Assisting in the recovery of land, freshwater, or marine ecosystem to a good condition, resulting in improved physical and chemical conditions.

3.3.3. Sustainable Finance Disclosure Regulation (SFRD)

The *Sustainable Finance Disclosure Regulation (SFDR)*[64] requires **asset managers and other financial market participants** to disclose sustainability related data. It aims to increase transparency in the financial market, particularly concerning sustainability risks, and to ensure that investors can make informed decisions based on the sustainability profiles of their investments.

[63] Platform in Sustainable Finance (2022, TSC).

[64] European Commission (2023, SFDR).

The *SFDR* applies to financial market participants and financial advisers within the EU. Asset managers, insurance companies, pension providers, and investment firms are required to disclose detailed information regarding how **they integrate sustainability risks into their investment decisions** and the potential impacts of their investments on environmental and social factors. While the regulation mandates transparency, it does not obligate financial market participants to consider sustainability criteria when investing. Rather, it necessitates justifying any sustainability claims made. Disclosures must be provided in specific formats, including on the entities' websites, in pre-contractual documents, and in periodic reports.

The *SFDR*'s mandatory ***Principle Adverse Impact (PAI)* indicator on biodiversity**, indicator 7, requires that companies disclose activities that negatively affect biodiversity sensitive areas (defined as "the share of investments in companies with sites or operations located in or near to biodiversity-sensitive areas, which negatively affect those areas").

Sustainable Finance Disclosure Regulation fund categories

- **Article 6** funds are the baseline classification and do not specifically focus on sustainability. These funds must still consider and disclose sustainability risks to the extent they are relevant to the investment, but they do not have a dedicated sustainability objective. If sustainability risks are not considered, these funds must explain why. Additionally, larger financial market participants must publish a statement on principal adverse impacts (PAIs) of investment decisions on sustainability factors, if applicable.
- **Article 8** funds, known as "light green" funds, promote environmental or social characteristics, and adhere to good governance practices, but do not have sustainability as their core objective. They need to detail how they meet these characteristics, for instance, by excluding certain harmful investments or considering ESG ratings in their investment decisions. Article 8 funds must disclose how and to what extent they adhere to these environmental or social characteristics, including in their investment strategies and asset allocation plans. While they encourage positive sustainability efforts, they don't require all investments to be sustainable.
- **Article 9** funds, or "dark green" funds, specifically target sustainable investments as their primary objective. These funds commit to economic activities that contribute to an environmental or social objective, under the "do no significant harm" principle. This means their investments should not harm any of the EU Taxonomy objectives significantly. They must choose a benchmark index aligning with their sustainability objectives and report how the investments meet these objectives. Article 9 funds are considered the most stringent in terms of sustainability requirements, aiming for positive contributions to society or the environment through sustainable investments.

▶ To sum up: As a result of multilateral agreements, regional regulation, and national implementation, we will see significant changes in legislation, taxation, financial flows, incentive systems and sources of income in many sectors, which in turn will have a significant impact on investment decisions.

Financial flows are being redirected on a grand scale: **subsidies that harm biodiversity are to be cut** by USD 500 billion. This will most likely lead to substantial resistance from the affected industries, as we have recently seen with the reactions of farmers to proposed cuts in subsidies.

Similar situations might arise in other industries with strong lobbies, such as the chemical industry. On the other hand, there will also be **positive incentive mechanisms** that can support the transformation of affected industries.

4 Biodiversity Solutions: The Power of Nature and Technology

Dr. Tobias Raffel

As outlined in the previous chapters, biodiversity loss – alongside climate change – has emerged as one of the most pressing challenges of our time, with profound implications for the resilience of ecosystems, human well-being, and the sustainability of our economic value creation (chapter 1). To address this challenge, binding global biodiversity targets have been agreed and are currently being translated into national policy and regulatory requirements (chapter 2).

This chapter now looks at the solutions we can use to conserve and sustainably utilize biodiversity.

The following approaches are particularly promising:

1. **Nature-based Solutions (NbS)** and
2. **Technology-based Solutions (TbS)**
3. A third option is **hybrid solutions** that combine nature-based and technology-based approaches and are thus the ideal way to actively reshape the economy (**hybrid solutions)**

This **video** shows how Nature-based Solutions can positively impact the environment in urban areas.

This **video** explores the possibilities of using life cycle engineering (Technology-based Solution) to make production processes more sustainable.

4.1. Nature-Based Solutions: Utilizing the Potential of Ecosystems

Nature-based Solutions (NbS) are actions that leverage nature to sustainably manage and restore natural ecosystems.[65]

Examples include:

- **Reforestation and afforestation**: Planting trees and restoring forests to absorb carbon dioxide, improve air quality and restore habitats for biodiversity.
- **Wetland restoration**: Restore wetlands to improve water filtration, provide habitat for diverse species, and buffer against storms and flooding.
- **Agroforestry**: Integrating trees and bushes into agricultural landscapes to increase biodiversity, improve soil health and increase agricultural productivity.
- **Mangrove restoration**: Reforestation and protection of mangrove forests to promote marine biodiversity, protect coastlines from erosion and sequester carbon.
- **Green infrastructure**: Utilizing natural processes and green spaces such as green roofs, urban gardens and permeable pavements to manage stormwater, reduce urban heat islands and improve air quality.

At the centre of NbS is the principle of **working with nature, not against it**. Over the past 4.5 billion years, nature has developed, tested, and refined solutions that often surpass human-engineered technologies in efficiency and effectiveness. From forests and wetlands to coral reefs and grasslands, diverse ecosystems offer a wealth of ecological and economic functions that underpin the health and resilience of the biosphere. By using NbS, we not only preserve biodiversity, but also improve ES such as carbon sequestration, water purification and climate regulation, which benefits people, business, and nature alike.

[65] IUCN (2020, Nature-based Solutions).

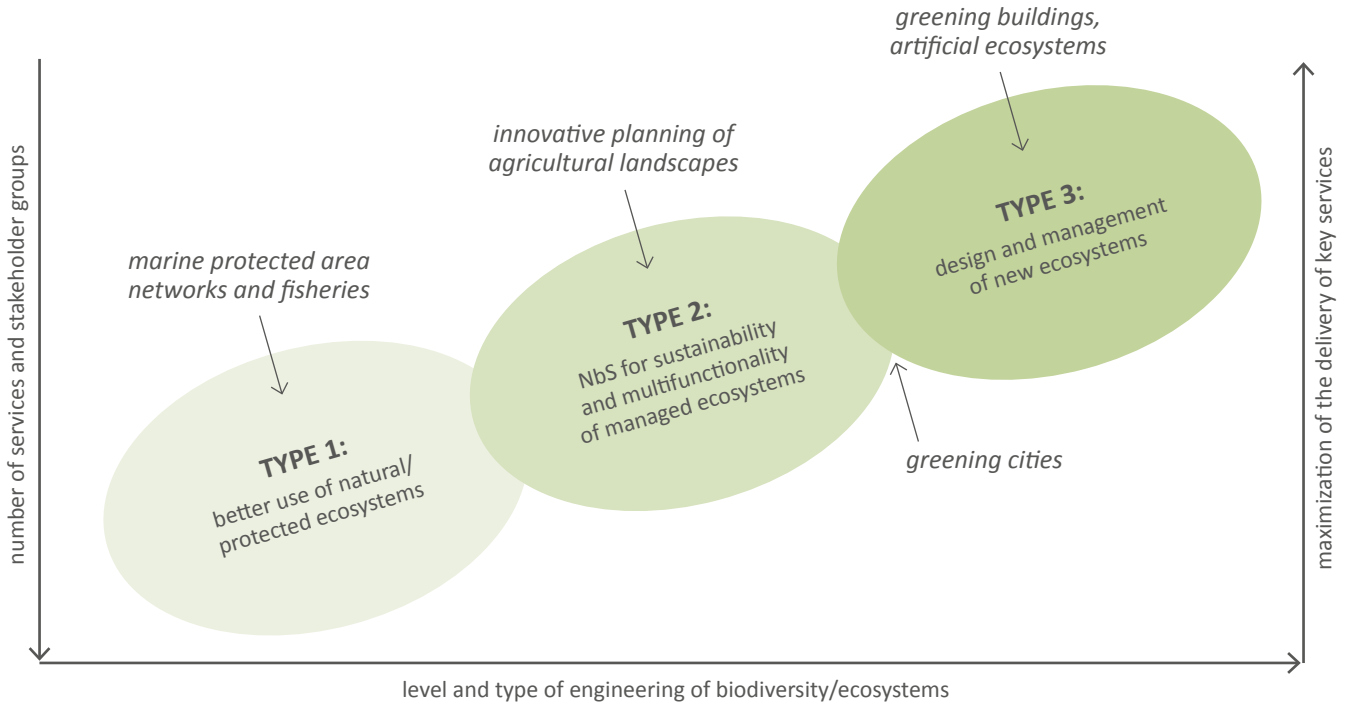
A distinction is usually made between three types of NbS (see **Figure 7**):

1. **Minimal intervention in ecosystems**: Type 1 NbS focus on **ecosystem conservation** to enhance a wide range of ES and protect biodiversity. The main aim is to make better use of natural and/or protected ecosystems. Examples include coastal mangrove protection and marine protected areas.
2. **Some interventions in ecosystems and landscapes**: Type 2 NbS include **some** ecosystem and landscape **interventions** to develop sustainable, multifunctional areas that improve specific ES. Examples include innovative agricultural landscape planning and agroforestry practices.
3. **Managing ecosystems in extensive ways**: Type 3 NbS describe **comprehensive management or creation** of new ecosystems such as green roofs or constructed wetlands to restore degraded areas and improve the urban environment.

- Currently, around **USD 200 billion is allocated annually to NbS**, with governments contributing 82 % of the total.[66]
- This is far below the amount required to meet global climate, biodiversity, and land degradation targets by 2030 and stands in stark contrast to the extensive investment in nature-damaging activities by both the public and private sectors, which clearly overshadows contributions to positive environmental action.
- The majority of public finance on NbS is spent on biodiversity protection as well as sustainable agriculture, forestry and fisheries, with five countries accounting for over 75 % of global biodiversity spending (US, China, Italy, France, and Germany).

Private funding for NbS, at **USD 35 billion annually** in 2022, is mostly channeled through **biodiversity offsets and credits and sustainable supply chains**. Although still relatively small in overall volume, philanthropic contributions saw the

Figure 7: Typology of Nature-Based Solutions



Source: Eggermontet al. (2015, NbSTypology) [67]

[66] UNEP (2023, State of Finance for Nature).

[67] Eggermont et al. (2015, NbS Typology).

most rapid increase, growing by 39 % from USD 0.96 billion to USD 1.34 billion compared to 2021, largely in support of the 30x30 conservation goal. Additionally, private funds leveraged by *Official Development Assistance (ODA)* rose by 31 %, from USD 0.55 billion to USD 0.72 billion, through mechanisms such as blended finance deals, including innovative financing instruments like "*Blue bonds"* and *"Rhino bonds"* (see chapter 5).

4.2. Technology-Based Solutions: Developing Innovative Technology

The counterpart to Nature-based Solutions are Technology-based solutions (TbS). TbS are actions that use innovative technologies to protect, restore and improve biodiversity and ecosystem services. Examples include:

- **Precision agriculture:** Using technologies such as GPS, drones, and sensors to optimize the use of water, fertilizers and pesticides to reduce environmental impact.
- **Biodegradable materials:** Developing materials that break down naturally and reduce pollution, such as biodegradable plastics and packaging.
- **Renewable energy systems:** Utilizing solar, wind, hydro and geothermal energy to cut carbon emissions and reduce habitat disruption from traditional energy sources.
- **Drones for reforestation:** Planting trees by shooting seed pods from drones into the ground at a fraction of the cost and time it takes humans to plant trees.
- **Monitoring and measurement technologies:** Using remote sensing for habitat mapping, DNA barcoding for species identification, bioacoustics for assessing ecosystem health, and AI for predicting wildlife trafficking patterns.

Technological advances have been central to human progress and development, and **we often tend to favour TbS over Nbs**. This is not only due to our education systems and cultural narratives but is also linked to our economic model:

- ▶ The global economy relies heavily on technological innovation to grow.
- ▶ Technological solutions can be patented, sold and exported, making them more attractive to business interests than nature-based solutions, which are often public goods and less easily commercialized.

However, there is also simply a lack of awareness or understanding of what nature has to offer and that business models can be built on the creation and use of ES.

Annual investments in TbS significantly exceed investments in NbS. In 2022, more than USD 1.3 trillion was invested in renewable energy systems alone, more than six times as much as all investments in NbS.[68]

When comparing NbS and TbS, the advantages and disadvantages of each solution become clear:

- **NbS** often require **lower investment and maintenance costs** compared to technological interventions. They are integrated into natural processes and can provide multiple benefits beyond biodiversity conservation. However, they can be **slower to implement** (e.g. reforestation) and are more difficult to measure.
- **TbS** allow for **precise monitoring and management**, and solutions can be scaled up quickly and applied in different regions. However, they can be **costly** and might have unintended negative impacts elsewhere. In addition, there can be issues with access and inequality, as not all communities may be able to afford or implement technological solutions.

4.3. Hybrid Solutions: Combining Nature and Technology

By integrating the best elements of both approaches, hybrid solutions can offer **more comprehensive, effective and sustainable results** in tackling the biodiversity challenge.

Examples of hybrid solutions include:

- **Integrated water resource management:** Combining natural watershed management techniques with advanced water treatment technologies to manage water resources sustainably.
- **Agrivoltaics:** Installing solar panels over farmland to use scarce land efficiently, create favorable microclimate and diversify the income streams of farmers.
- **Wind farms and algae farms:** Integrating algae cultivation with wind farms to use land efficiently, provide new habitat for species and sequester carbon.

[68] IRENA (2023, Renewable Energy Finance).

- **Swimming photovoltaic panels:** Installing solar panels on lakes and calm rivers to reduce evaporation, control algae growth and use land efficiently.
- **Green buildings:** Integrating natural elements such as living walls and rain gardens with energy-efficient technologies to create buildings that reduce energy consumption, promote biodiversity and improve air quality.

Hybrid solutions often encompass the idea of "**dual use**", meaning that they are designed to serve multiple purposes or address more than one problem simultaneously:

- Agrivoltaic systems produce renewable energy while also supporting agriculture, or green buildings that provide living spaces while also enhancing biodiversity.
- In addition, many hybrid solutions follow the logic of the circular economy principles by reducing the strain on natural resources, decreasing habitat destruction, and lowering pollution levels.

4.4. *Business Action: The "Footprint, Handprint, Heartprint" Approach*

As the previous section has shown, nature and technology can help address the biodiversity challenge in many fascinating ways, and there is a growing number of smart ideas to combine both types of solutions.

To make these solutions work, a **collaborative approach** is needed: Science and business design innovative solutions, policy regulates and incentivizes them, the private and public financial sectors finance them, and (in many cases) businesses implement and run them.

Today however, the **business sector** is still predominantly part of the problem and **not yet (enough) part of the solution** to the global challenge of biodiversity loss: All the five main drivers of biodiversity loss – land-use change, overexploitation of resources, pollution, invasive species, and climate change – are all closely connected to business activity, and economic value creation typically comes at the expense of harmful externalities. Only if we transform from nature-negative to nature-positive business practices we can effectively address the biodiversity challenge.

Nature-positive transformation needs to happen in both corporate headquarters and global supply chains:

- **At the headquarters,** *nature strategies are designed, targets and milestones are set*, (financial) resources are allocated, an effective governance is set up, and reporting and communication is prepared.
- **In the global supply chains,** most *measures to protect, restore and improve biodiversity* and ecosystem services will be developed, implemented and monitored – often in close cooperation with local communities and business partners.

There is a growing number of guidance and tools developed by science, policy, and civil society to help companies in their steps towards nature positive – including risk assessment tools, target-setting guidelines and blueprints to develop a biodiversity strategy.

Guidance for Corporate Biodiversity Action

ENCORE by *UNEP Finance Initiative* et al.
The *ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure) tool* is an online platform designed to help organizations understand their impacts and dependencies on nature. It is particularly useful for financial institutions to identify nature-related risks in their investments, with a focus on sectors such as agriculture and mining.

Biodiversity Risk Filter by *WWF*
The *WWF Biodiversity Risk Filter* is a tool designed to help companies and financial institutions identify and mitigate biodiversity-related risks in their operations and investments. It provides a heatmap overview of the impacts and dependencies of biodiversity and helps to develop nature-friendly business models.

Science Based Targets for Nature (SBTN) by *SBTi*
The *Science Based Targets for Nature (SBT for nature)* enable companies to identify science-based environmental targets. The first nature objectives relate to impacts on freshwater quality (especially nitrogen and phosphorus), freshwater quantity and terrestrial ecosystems, and it includes a 5-step process for putting science into action.

Taskforce on Nature-Related Financial Disclosures (TNFD)
The *TNFD* has developed a set of disclosure recommendations and guidelines to encourage and enable companies and financial institutions to assess, report and act on their nature-related dependencies, impacts, risks and opportunities (for more details, see chapter 6).

Nature Strategy Handbook by Business for Nature
The handbook is a practical guide to develop a biodiversity strategy. It provides guiding questions, recommendations, and resources, and takes into account the requirements of various frameworks, guidance, and regulations.

All tools and guidelines are publicly available and can be used free of charge.

A pragmatic approach for companies to get started with biodiversity action, while at the same time applying **a comprehensive and positive narrative** that goes **beyond risk analysis and regulatory compliance**, is "footprint, handprint, heartprint".[69]

The framework suggests that companies can and must act on three levels: Reduce negative impact (footprint), increase positive impact (handprint), and create transformative impact (heartprint):

- **Footprint:** Companies can reduce their negative impact on nature by avoiding harmful practices such as deforestation and pollution, and by reducing the overexploitation of natural capital, e.g. of land, water, and raw materials. The imperative is: **Do no harm!**
- **Handprint:** Companies can increase their positive impact on nature by helping to improve the state of nature, e.g. through conservation and restoration measures, and by transforming to circular, regenerative, and nature-positive business practices. The imperative is: **Do good!**
- **Heartprint:** Companies can also create transformative impact by winning people over for the cause of nature. Communicating positive narratives, sharing success stories, learning from best-practice examples, setting incentives for nature-positive action, and facilitating collaboration in the global supply chain are measures that can be started immediately. The imperative is: **Win hearts for biodiversity!**

Figure 8: Footprint, Handprint, Heartprint Approach

FOOTPRINT
Reduce your negative impact

Avoid
harmful practices
(e.g. deforestation)

Reduce
overuse of natural capital
(e.g. land, water, raw materials)

HANDPRINT
Increase your positive impact

Improve
the state of nature
(e.g. conservation, restoration)

Transform
to nature-positive practices
(e.g. circular, regenerative)

HEARTPRINT
Win hearts for biodiversity

Collaborate
with partners and competitors
(e.g. in supply chain)

Communicate
a positive narrative
(e.g. best practices, success stories)

Source: Raffel et al. (2021, Footprint, Handprint, Heartprint) [70]

[69] Raffel et al. (2021, Footprint-Handprint-Heartprint).

[70] Raffel et al. (2021, Footprint-Handprint-Heartprint).

On all three levels, NbS, TbS and a combination of both can be applied in many ways. But then of course, any such solution needs to be financed, and this is where the financial markets and investors come in: Investors play a crucial role in the nature-positive transformation by redirecting capital to sustainable and environmentally friendly projects.

Investors can encourage companies to adopt more sustainable practices by incorporating environmental criteria into their investment decisions, offering financial products that support biodiversity and working with companies to improve their environmental performance. They can also support the development of markets for nature-friendly investments and require transparency and disclosure on environmental impacts and dependencies. The following chapter will look at the opportunities in financing nature and ES.

5 Investment Opportunities: Financing Nature Conservation and Restoration

Antje Biber

Despite the increasing awareness of the risks (physical and transition risks) posed by biodiversity loss, financial institutions are still grappling with the clarity and extent of opportunities for direct positive impact from investments. Challenges persist in measuring impact, monitoring progress, and generating meaningful returns while simultaneously supporting natural ecosystems. These hurdles remain prevalent despite the mounting regulatory pressure from political entities and regulators in recent years.

- Moving forward, it's imperative to acknowledge that addressing biodiversity is not only ethically responsible but also **in the best interests of the institutions involved**.
- **The financial risks** associated with biodiversity loss are intimately connected to the accelerating loss of biodiversity and the evolving policy framework.
- As we navigate these **complexities**, it becomes crucial to delve deeper into the strategies and mechanisms required to integrate biodiversity considerations effectively into financial decision-making processes.

Consciously considering the **impact of economic activity** on nature and ecosystems can both reduce risk and open a wide range of opportunities, including new business, collaboration, and investment opportunities. **Financial institutions have therefore a critical role to play** by redirecting financial flows away from negative impacts on nature and towards positive outcomes for nature.

- **Investors** are becoming **increasingly aware** of the opportunities and impacts on nature and ecosystems, supported by a wide range of regulatory changes, new incentive systems and a fundamental shift in thinking towards responsible investment.
- In addition, the **requirements and decisions of central banks and supervisory authorities** play a key role in the implementation of investment solutions, especially for large institutional investors.

Back in April 2021, these institutions founded the "***Network for Greening the Financial System (NGFS)*** – *International Network for Sustainable Financial Policy Insights, Research, and Exchange (INSPIRE) Study Group on Biodiversity and Financial Stability"* to develop a research-based approach on how they can fulfil their mandate in the context of biodiversity loss.

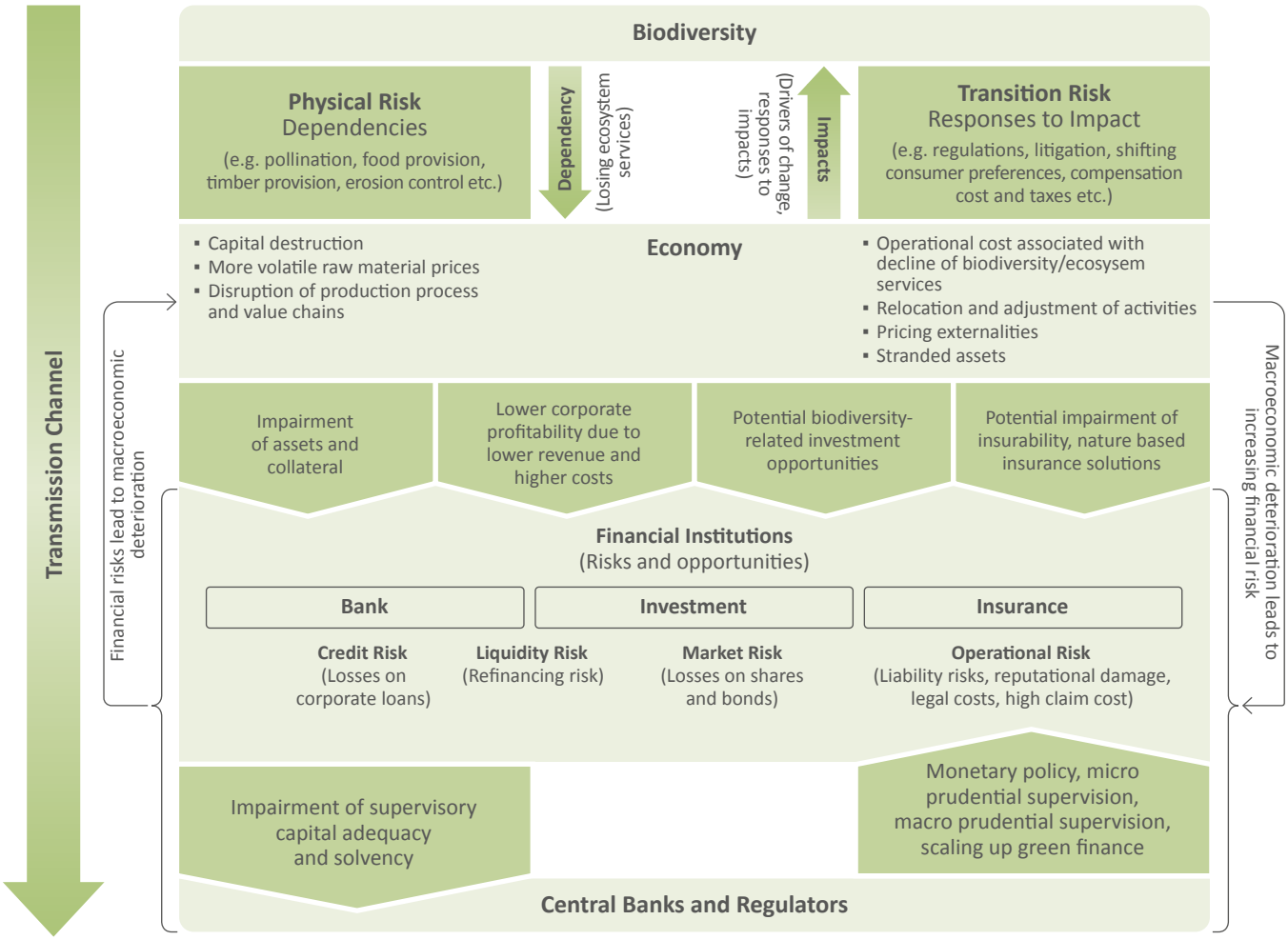
- This is an illustration of the **scope and economic importance of biodiversity issues in the risk assessment of financial systems.**
- It emphasizes the importance of effective policies and legislation to respond to the long-term economic risks of biodiversity loss and to support the enhancement of nature.

Financial institutions are directly affected by the physical risks arising from the economy's dependence on nature. The following figure (Figure 9) shows the close link between economic and financial risks and the effects of change and negative impacts on nature and biodiversity. At the same time, the identical financial market participants are **exposed to long-term transition risks** due to the negative impacts of economic activities on nature.

This demonstrates how closely the economy and the financial markets are intertwined with the structural alterations of the ecological systems.

Alongside the commitment and efforts of public authorities**, several international initiatives** and dedicated groups of investors have already joined forces to increase knowledge about the impact of investments on nature and to develop concrete solutions and standards for the financial sector.

Figure 9: Biodiversity, the Economy and the Financial System – Interdependencies



Source: NGFS-INSPIRE Study Group (2022, Biodiversity and Financial Stability) [71]

Finance for Biodiversity Foundation

Overall, 163 financial institutions from 24 countries with assets of more than EUR 21.4 trillion have signed the 2023 *Biodiversity Futures Initiative (BFI) Commitment*. Initiated by a group of 26 financial institutions appealing to global leaders, the Pledge commits to protect and restore biodiversity through finance and investment. The launch took place at the *Nature for Life Hub* on 25 September 2020 and at the *UN Biodiversity Summit* on 30 September 2020. The Foundation, established in March 2021, acts as a **liaison for contributing** signatories and partner organizations, supporting the **call to action** and collaboration among financial institutions through working groups. These working groups cover corporate engagement, impact assessment, including biodiversity measurement and data, public policy advocacy, target setting and positive impact.[72]

[71] NGFS-INSPIRE Study Group (2022, Biodiversity and Financial Stability).

[72] Finance for Biodiversity Foundation (2024, Investment Network).

Natural Capital Investment Alliance (NCIA): Initiative of mayor investment players

The *NCIA* is another initiative, that aims to accelerate the development of natural capital (the world's stock of natural assets, including geology, soil, air, water and all living things) as a mainstream investment theme. The *NCIA* was launched by HRH The Prince of Wales through his Sustainable Markets Initiative, with *Climate Asset Management, Lombard Odier* and *Mirova* as founding members. *NCIA*'s objective is to attract members of the financial community by creating scale and synergies among major asset owners and asset managers. The initiative intends to serve as a **central hub for global companies and financial institutions** that are seeking to expand their investments in natural capital to support the restoration of biodiversity, including through high integrity carbon offsets. The idea is to share investment knowledge and expertise on investing in natural capital, underpinned by strong principles, as well as to showcase and demonstrate the scalability of appropriate investment vehicles and the range of opportunities across asset classes.[73]

Taskforce on Nature Markets: Collaboration of Corporates & Finance

The Taskforce aims to raise awareness of nature markets, develop communities of practice, foster innovation, develop a roadmap with recommendations for key stakeholders and highlight some exemplary flagship initiatives. It proposes an ambitious and practical governance framework. The goal is to **engage and connect active, aligned communities of practice**. This approach will be led by a group of members from the fields of policy, law and governance, market, technology, civil society, and indigenous communities. A dedicated group of knowledge partners will support the members.[74]

The scale and number of international activities is an indication of the growth in attention and relevance of the role and influence of the financial sector. Overall, the biggest challenges at present are certainly still:

- the incomplete knowledge of interdependencies,
- the unclear and sometimes unmeasurable effects and
- the basic availability of investment opportunities.

Nevertheless, there is a very dynamic development in various segments and asset classes.

Existing solutions and investment innovations related to nature-based investment opportunities are highlighted in this section of the study. In the context of well-known asset classes, the interdependencies between the investment objectives, constraints and regulatory requirements of institutional and private investors are discussed.

5.1. Monetization of Nature Protection: Biodiversity Credits, Conservation Bonds & Tokenization

The central objective of current multilateral initiatives is the **conservation, restoration, and sustainable management of biodiversity.**

▶ The big question is: How to monetize the value of ecosystem services to ensure conservation?

There are already several innovative solutions for the quantification of the value of ecosystem services and the use of financial instruments to make this valuation and a measurable improvement investable or to convert their value into a price for economic activities. In general, the aim is to develop financing options to cover the costs of restoration and protection of nature and the environment.

5.1.1. Biodiversity Credits

One of the instruments that has gained momentum in recent years is **biodiversity credits**. The biodiversity credit markets can significantly contribute to bridging the existing nature finance gap and unlock growth opportunities associated with improved nature outcomes by increasing the scale and effectiveness of these efforts.

[73] NCIA (2024, Market Initiative).

[74] Nature Finance (2024, Taskforce).

A ***Biodiversity Credit*** is a tradeable unit that represents a positive biodiversity outcome achieved by a nature-based solutions project registered under a biodiversity credit scheme that is based on scientifically derived and measurable metrics for biodiversity, and which is not used to offset an equivalent negative impact on biodiversity elsewhere.[75]

In the fight against biodiversity loss, data-driven strategies are pivotal. AI as a monitoring solution can transform raw data points into actionable intelligence, empowering decision-makers to gain unparalleled visibility into ecosystem health.[76]

Florian Geiser, Co-Founder & CEO *Hula Technologies GmbH*

Reliable, standardized and clearly measurable biodiversity credits could **deliver multiple benefits** to businesses, including reducing physical natural risks, promoting positive natural outcomes in line with consumer preferences, keeping pace with regulatory changes, supporting a robust social license to operate, reducing reputational risks, securing competitive funding to attract talent, and increasing employee engagement and retention.

One of the biggest challenges for biodiversity credits is **measuring and verifiably quantifying the improvement in ecosystem services**, natural resources or simply the natural state that is being financed. While globally accepted standards for measuring emissions and carbon sequestration already exist for carbon credits, there are already accepted metrics for measuring biodiversity, such as *Mean Species Abundance (MSA)*, but the difficulty is the measurement itself.

- How to **reliably measure** species numbers, evolution, and interdependent and complex ecosystems at greater scales?

Innovative technologies that combine satellite information with artificial intelligence are one possible solution.

***Hula Earth* – AI for biodiversity credits**

Hula Earth is a German high-tech start-up. As part of the *Biodiversity Credit Alliance*, which is led by the UN and the *World Economic Forum* (*WEF*), *Hula Earth* is currently helping to shape the future metrics and guidelines for biodiversity credits and is primarily representing the interests of European projects for flora and fauna. **Measurability is the most important key and success factor for biodiversity certification**. The combination of remote sensing data, Internet of Things (IoT) sensors and artificial intelligence (AI) is a possible solution for transparent monitoring. It is the technological key to scalable, cost-effective, and transparent biodiversity monitoring.

The issuance of biodiversity credits requires the continuous monitoring of biodiversity projects, not only to ensure that they are achieving the desired objectives and impacts, but also to identify risks at an early stage, which can then be addressed in a targeted manner. Hula achieves this by combining satellite data with information gathered from IoT sensors. These sensors are specifically designed by Hula to monitor biodiversity and provide insights into local fauna through bioacoustics, microclimate, and other ecosystem services. The integration of satellite data allows the IoT measurements to be put into context and complements them with other insights such as the health and composition of the vegetation.

[75] Taskforce on Nature Markets (2023, Biodiversity Credits).

[76] Hula Technologies (2024, Biodiversity Investments).

AI plays a crucial role in analyzing the data obtained from monitoring biodiversity. It helps to understand complex relationships in ecosystems, predict future trends and derive recommendations for action. Using AI, species of animals and plants can be identified, and precise actions can be taken to promote biodiversity.[77]

The **market for biodiversity credits** is still in its infancy, with a very limited overall market and supply, and a lack of clear guidelines and standards. Therefore, business risks need to be assessed and considered in advance. These include strategic risks due to insufficient impact and dependency analysis, operational risks due to insufficient number of credits, and of course reputational risks due to lack of controls or fraud.

The **lack of standardization and potential misuse** of biodiversity credits can be detrimental to nature and local communities, and a source of operational and reputational risk. In particular, if credits are perceived as a substitute for meaningful efforts to avoid and reduce negative impacts on nature, there is a massive risk of greenwashing.

The most controversial use of **biodiversity credits – offsetting** – should also be seen in this context.

- Here, companies use credits to compensate for unmitigated negative impacts of their activities on biodiversity.
- Whether and when voluntary biodiversity credits can be used in this way is currently the subject of intense debate.
- At the same time, this financial instrument offers a **variety of opportunities to provide financial support** for positive impact on nature and biodiversity, while at the same time creating economic value.

Biodiversity Credits: Various Utilization Options and Scenarios[78]

A) Improving carbon credits for better nature outcomes
Carbon crediting projects already issue credits with a biodiversity "premium" that explicitly contributes to enhancing biodiversity as an integral part of the carbon credit. As more organizations have nature-based objectives, projects that explicitly enhance biodiversity could issue carbon credits and biodiversity credits separately for the same project, provided additionality rules are met. This use case is specifically interesting for future "blue carbon" projects. Example: Accumulation of carbon and biodiversity credits from a mangrove restoration project could simultaneously improve climate and nature outcomes.

B) Improving ecosystem services as a business input
Companies could use biodiversity credits to finance improvements to the natural capital in their value chain to access and enhance the ecosystem services on which they depend. Thus, they could achieve positive results for nature while generating business benefits. Example: A confectionery company that buys berries directly from a farmer could buy biodiversity credits from the local landscape to protect pollinators essential for the fruit's growth.

C) Combining projects/products with nature restoration
As an additional product feature, companies could consider offering products and services that allow consumers to buy nature improvements. A product bundled with biodiversity credit offers consumers a convenient tool to directly influence positive outcomes for nature through their consumption choices. However, to ensure that this use case does not support greenwashing, credible advice and effective verification of claims are essential.

D) Corporate engagement and environmental contribution
To support global conservation goals and the ecosystem services on which the global economy depends, more and more companies want to contribute to the protection and restoration of nature beyond their own direct and indirect impacts. Particularly in the financial sector, activities and initiatives explicitly focused on improving and supporting biodiversity are growing. Corporations and financial institutions are publicly acknowledging the need to act and the desire to contribute financially. Biodiversity credits can provide a measurable and verifiable solution.

[77] Hula Technologies (2024, 2024, Biodiversity Investments).

[78] WEF (2023, Biodiversity Credits).

It would be an important lever if biodiversity credits could also be recognized as a relevant activity in the *EU taxonomy* report. However, this still needs to be determined and requires clear specifications, standards, and guidelines. Biodiversity credits and a range of other instruments, such as direct investments in restoration projects, contributions to conservation organizations or positive lobbying, could be used to support each of these use cases.

- The choice of instrument should anyhow be a case-by-case decision for companies, with an eye to complementarity between different instruments.

Finally, due to the fact that the biodiversity credit market is still very young it requires further development. Although, through the certification of a measurable impact on nature and/or the climate, this market can have an important role in the implementation of ecosystem protection and restoration.

- A key success factor will be **future global standards and reliable verification** systems, similar to those for carbon credits.
- At the same time, it must be clear and transparent who is the purchaser of biodiversity certificates and for what purpose.

A very recent new legislation in the UK could be a possible enforcement route for a meaningful compensation obligation for negative damage to nature and biodiversity.

Biodiversity Units & *Biodiversity Net Gain (BNG)* – An innovative financing solution by the UK government, January 2024

One solution to ensure credible implementation and measurability could be newly invented **'Biodiversity Units'**. These are a new scheme introduced by the UK Government to help improve biodiversity and help tackle climate change. The UK government announced with the 2021 *Environment Act* that from January 2024 (April 2024 for smaller sites), all development projects must make sure that, as a condition of planning permission being approved, they increase the net gain of the biodiversity of an area by a minimum of 10 % compared to the predevelopment biodiversity value.

The concept is that every company operating in the relevant sectors, particularly in the **development and construction industries**, must improve the biodiversity value of the land it develops. The new rules are that there must be a **10 % improvement in biodiversity** through what is known as ***BNG*.** If you are unable to demonstrate how you are going to achieve this at the planning permission stage, you will not be allowed to go ahead with the project. This is done by creating and purchasing biodiversity units to compensate for any damage you may cause. Ideally, these will be created on the same site where the project is to be carried out. However, if it is not possible to do this on the construction site (and this is often the case), you will need to buy biodiversity units from independent sellers away from the construction site. These may be farms, local authorities, private landowners, or others.

A **special measurement and pricing tool** has been developed for the *BNG* and the *BNG* market: the biodiversity metric. All data, whether from contractors, ecologists, local planning authorities or land managers, is collected and verified using this tool. Therefore, purchasing biodiversity units is a mandatory part of the planning and permission for all development or construction companies and is required to obtain approval from the relevant local planning authorities. The market and prices are therefore transparent, and the incentive structure is clearly defined. The future will show whether this will even lead to the development of a trading market.[79]

5.1.2 Nature Conservation Bonds – a Multilateral Solution

The establishment and management of protected areas, such as national parks or marine reserves, is usually the **responsibility of a state**, as the largest areas are often state-owned. However, the ongoing management, conservation and protection of nature requires **significant financial resources**. It is often difficult for many countries, especially those in emerging markets and developing countries, to raise these sums of money. To protect or restore nature in these countries, there is a need for financial instruments that can be used by government owners, but that also

[79] Gaia (2024, Biodiversity Net Gain).

ensure that the **money is well targeted**. The *World Bank* has recently developed a very focused facility for this purpose, the *Wildlife Conservation Bond*.

World Bank*'s USD 150 million *Wildlife Conservation Bond (WCB)

The World Bank's USD 150 million *WCB* is the first results-based bond of its kind to support the financing of conservation activities and, together with grant-based financing from the *Global Environment Facility (GEF),* will transfer project risk from donors to investors. The transaction mobilizes private capital to finance black rhino conservation in two South African conservancies, *Addo Elephant National Park* and *Great Fish River Nature Reserve*.

The *WCB* is a USD-denominated, capital protected *World Bank* Bond, also called **"Rhino Bond"** It has a maturity of 5 years. Investors in the *WCB* do not receive coupon payments. Instead, the *World Bank* makes investment payments to the two conservancies to fund rhino conservation. At the end of the term, investors will receive a **performance payment linked to the growth rate of the black rhino population** in the two parks. The growth rate of the rhino population will be calculated and verified by independent parties over the life of the bond. The maximum payment for the conservation success amounts to USD 13.76 million, i.e. just over 9 %. This AAA bond, which is listed in Luxembourg, demonstrates the enormous efforts of international institutions to create investment solutions that are both attractive and have a high positive impact on the environment.[80]

5.1.3 Nature Token

To **mobilize private capital for environmental protection** in addition to public funding, entirely new alternative instruments are opening up, which are in line with progress towards the **technologization of financial investments**. One very innovative way of financing environmental protection is the tokenization of nature. In this solution, units of impact on nature are calculated and then made available for purchase in the format of tokens. The goal is to ensure that all activities and funds raised are invested in restoring the integrity of the ecosystem:

- **Example 1 "Land Token":** In this case each token can **represent a one-hectare share of a plot of land** that is used for a nature restoration program. A range of benefits that create a closer personal connection to the restoration story are available to owners of these tokens. Their investment will provide progressive landowners with the opportunity to fund ecosystem restoration as an asset that generates multiple forms of value and contributes to the community. The tokens can be issued in different editions to represent different stages of restoring the ecosystem, including:
  - (1) **reset,** where active restoration is required because ecosystems have reached a state of un-recoverability without restoration,
  - (2) **recovery**, where ecosystems retain or have regained some integrity, and a process of self-recovery and self-maintenance is underway, and
  - (3) **steward**, where ecosystems have high integrity and capacity for self-regulation and adaptation.
- **Example 2 "Wildlife restoration Token":** These tokens are used to invest in re-colonizing areas with species which are involved in ecological recovery (these species are often called 'ecological engineers' or 'ecological architects'). Each **token represents a share in the restoration of a healthy population** of a functional species in a given area. Investment in the token results in an increase in the population by a predicted number of animals. A range of benefits that create a closer personal connection to the recovery story are available to token holders. The investment will provide conservationists and progressive landowners with the financial means to populate the land with species that will support the recovery and functioning of the ecosystem.

Tokenization refers to a small-scale denomination and digital representation of real or intangible assets. Each fraction represents a fixed value as well as defined rights and obligations. The process is based on blockchain technology.

[80] World Bank (2023, Wildlife Conservation Bond).

Nature+ token

Nature+ token is a specialized natural asset investment vehicle that enables everyone to earn interest through appreciating natural assets e.g., planting new trees, and regenerative use of other natural resources. The natural assets industry is a legacy industry with funds locked up for years. By leveraging Decentralized Finance (DeFi) and crypto mechanics.

A so called stablecoin pegged to the USD is backed by a dynamic portfolio of global natural assets. Nature+ will mint stablecoins equivalent to the USD value of the pool of assets, including a margin of safety to minimize risk exposure and ensure they are always backed at least 100 % by physical assets. The value of the asset pool will be secured by a third-party auditor to make sure the token are always backed by physical assets.

The stablecoin is an agnostic asset-ledger-backed token originally designed as an ERC20 token on the Ethereum blockchain. Nature+ incorporates an interoperability solution to allow users to trade and benefit from our tokens via the blockchain of their choice. This will be done through a seamless user experience with no intermediaries. Ledger agnosticism (the ability of a token to exist on multiple blockchains) has become revolutionary for the crypto space and is an important step in achieving widespread adoption.[81]

The ***decentralized financial system (DeFi)*** is a digital financial ecosystem based on the blockchain, more precisely on the basis of Ethereum and mostly on open-source protocols and modular frameworks. This allows digital assets to be created and issued.

The **improvement of brand reputation** and the increase of PR value for companies are mentioned as objectives and purchase motivators for token as well as biodiversity credits. **Credible and measurable impact reports** embedded in the sustainability reporting process can be an additional benefit in this respect. At the same time, the tools are expected to contribute to improving employee loyalty and recruitment as well as internal benefit packages.

It remains uncertain to what extent nature tokens will be able to contribute to the commitment of companies to the environment. **Transparency and traceability of the pricing and the implementation** will be of crucial importance, also to this endeavour.

5.2 Blended Finance: Cooperation of Public & Private Capital

The public sector has a key role to play in supporting private sector investment through **risk mitigation** mechanisms.

Blended finance is an approach where **public funds** are used **to change the risk and return profile** of investment projects to **attract private sector** participation. Grants, concessionary loans, and other co-financing instruments (called blended finance) can be used to support the use of nature-based solutions. Blended finance combines public development finance and private capital flows into emerging markets and developing economies to create a **win-win situation for investors and funded operations**. Public participation is a de facto subsidy. It can make the investment attractive to commercial investors.

[81] Nature+ (2024, Nature Token).

Activities such as nature and agricultural restoration in developing regions are based on **new business models** and **face specific challenges** that the private sector is reluctant to tackle alone, or that result in return requirements that would jeopardise the environmental and social sustainability of the projects. Public financial institutions are at the same time increasingly interested in using their balance sheets to attract private investors and capital.

The public sector usually takes over the **first loss tranches** (senior tranches). Private investors are protected from capital losses in the event of insolvency of the subsidized development projects.

However, in the case of blended finance, the public sector waives these senior tranches, which are normally remunerated with a higher return for the higher risk assumed. **In this way, investors should be able to earn a return close to the market rate with a significantly reduced risk**.

Today sectors such as energy and infrastructure, where projects deliver services, generate revenue and have clearly measurable financial returns, account for the majority of blended finance transactions. Nevertheless, even if ES are not yet fully recognized in the economy, **blended finance instruments can play a crucial role** in bringing nature investments into the mainstream in the future.

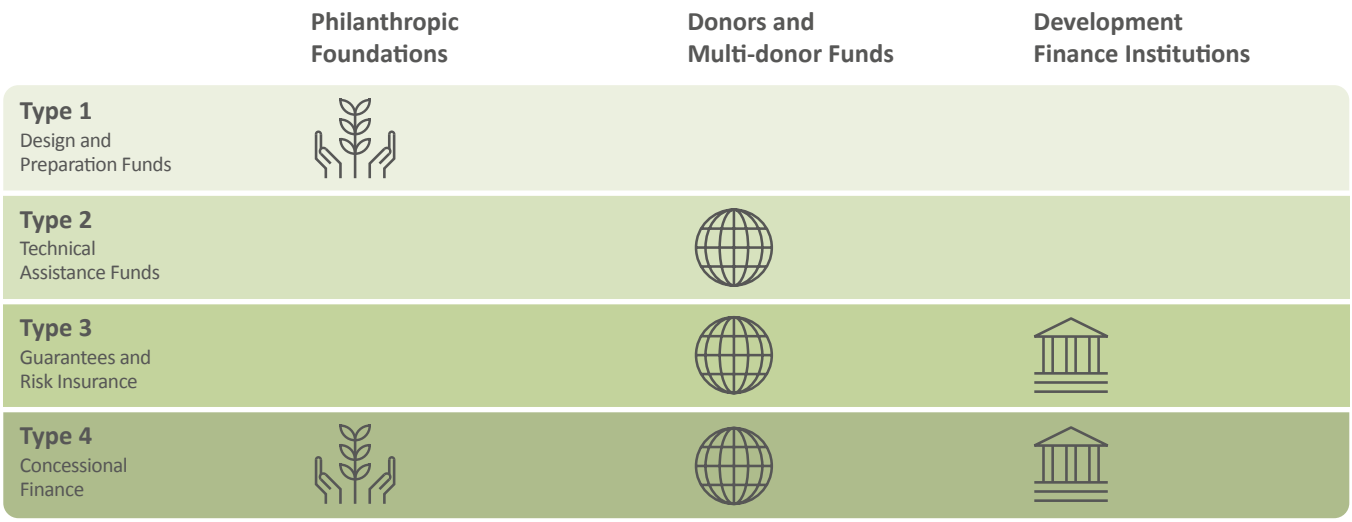
A 2022 report by *Earth Security Group*[82], in partnership with *HSBC*, lists **31 active investment vehicles** (funds, facilities and bonds) using blended finance as an approach to advance the protection of nature's ecosystem services (only 5 % of all blended finance vehicles in use across all investment sectors). Their combined fundraising target was just over **USD 5.1 billion**. The report identifies four main types of blended finance for nature. These offer a range of options for layering capital to incentivize investment in NbS.

Often, blended finance instruments combine many of these forms of financing in one transaction, depending on the needs and complexity of the investment:

- Type 1: **Design and preparation grants** are used to support proof of concept, establish a baseline and monitoring and verification system, develop a pipeline, and provide the **pre-commercial funding** required in the early stages of an investment thesis or vehicle (grant funding by philanthropic organization).
- Type 2: **Technical assistance grants** are used to build the technical capacity of investees and key stakeholders, such as local communities, which can be critical to the successful implementation and ultimate economic viability of projects.
- Type 3: **Risk guarantees** protect investors against losses, as part of a capital structure. This de-risks projects that are initially perceived to be too risky by private investors. The guarantor (mostly Public Banks) will agree to cover the loss (in full or in part) of a third-party financing transaction in the case of non-repayment or loss of value. Guarantees allow transactions to attract capital at **more favourable rates**. Other risk mitigation instruments such as **political risk insurance** play a similar role.
- Type 4: **Concessional finance** is provided by public entities on more favourable terms to mobilize commercial capital. Debt or equity at below-market rates helps to lower the overall cost of capital and mobilize finance from more risk-averse investors. This includes accepting subordinate, or junior terms (first-loss or junior equity) compared to other co-investors. Concessional loans can also effectively reduce the overall interest rate of financing if other lenders provide market-rate loans, thereby improving the affordability of finance to the investee. Concessional capital can also be provided conditional on a pre-agreed set of results ('impact-linked loans' or 'results-based financing'), which provide investors with the assurance that financing will be effectively tied to its intended ecological and social impact.

[82] HSBC (2022, Blended Finance).

Figure 10: Blended Finance Types and Likely Providers



Source: HSBC (2022, Blended Finance) [83]

A current example of outcome-based financing as a special form of blended finance is the *eco.business Fund*.

eco.business Fund[84]

The *eco.business Fund*, advised by *Finance in Motion*, supports biodiversity conservation, the sustainable **use of natural resources and climate change action** by providing private debt to businesses in Latin America and the Caribbean, and sub-Saharan Africa, serving each region through a separate sub-fund. Funding is provided through financial institutions – such as local banks and microfinance institutions – as well as directly to businesses and corporates, focusing on the target sectors agriculture, fisheries, forestry and tourism. To ensure environmental benefits, the fund has defined a strict use-of-proceeds criteria: final recipients need to either hold a pre-screened sustainability certification (such as *Rainforest Alliance* and *FSC*) or **implement a sustainable business practice included on the fund's "Green List".** Alignment with the fund's requirements is regularly monitored and feeds into the impact reporting.

The fund leverages capital provided by public investors such as the ***German Ministry for Economic Cooperation and Development*** as well as **the EU** to attract capital from private institutional investors. The blended structure of the fund, which provides substantial capital protection from its share base, offers **institutional investors notes with 3–5-year maturities and market-based returns**, with coupons varying depending on the level of seniority in the capital structure. By the end of 2023, the fund has mobilized more than **USD**

[83] HSBC (2022, Blended Finance).

[84] Finance in Motion (2024, Eco.Business Fund).

928 million in Latin America and more than **USD 127 million** in Sub-Saharan Africa. Nearly 50 % of capital in Latin America comes from private investors.

In addition to providing funding, the fund's Development Facility supports financial institutions and businesses with tailored capacity building or advisory services to facilitate the adoption of sustainable practices and enhance their environmental and social management capabilities.

One of the most important institutions driving this process is the *Global Environment Facility (GEF).*

Global Environment Facility (GEF)[85]

The *GEF* (External link) was founded in 1991 and is one of the most important multilateral funds for the protection of the global environment. It serves as a financing instrument for six UN environmental conventions and agreements, including the ***UN Framework Convention on Climate Change (UNFCCC)*** and the ***Convention on Biological Diversity (CBD)***).

It is a family of funds dedicated to confronting biodiversity loss, climate change, pollution, and strains on land and ocean health. Its grants, blended financing, and policy support help developing countries address their biggest environmental priorities and adhere to international environmental conventions.

Over the past three decades, the *GEF* has provided more than USD 23 billion and mobilized USD 129 billion in co-financing for more than 5,000 national and regional projects. The *GEF* serves as a financial mechanism for several environmental conventions.

To increase the involvement of private investors in blended finance transactions, there must be **better communication of the positive investment outcomes** of these instruments. In particular, to support results-based financing options that can link financing to positive increases in ecosystem services, **greater transparency** on their impacts is also needed.

Finally, a key barrier for institutional investors, such as pension funds, is the **scale of transactions**. This will be a challenge for specific projects, where the aggregation into larger investment options will be increasingly important for the distribution of these opportunities to investors and the scaling of the sector.

- Nevertheless, blended finance offers a promising opportunity to invest in targeted conservation and restoration activities. **Risk/return optimization and impact orientation** are likely to be the main drivers for increased involvement of private investors.

5.3 Labelled Bonds: Emerging Sustainable Finance Instruments

Some investors use the term "labelled bonds" to describe debt instruments that finance a specific purpose. In most cases, however, they are still often referred to as "**green bonds**". This special form of financing could not only help companies in the economic transformation towards more environmentally friendly measures for damage prevention or restoration, but also provide investors with a standard market return, a known credit rating and, in addition, a transparent and positive impact on the environment. This section describes the opportunities for financing biodiversity through the bond market. The focus of the analysis is on the so-called labelled bond market.

5.3.1 Labelled Bond Market and Standards

Labelled bonds are earmarked bonds with specific environmental or social objectives. Their proceeds are used exclusively to (re)finance eligible projects with environmental benefits (Green Bonds), positive social outcomes (Social Bonds), or a combination of both (Sustainability Bonds).[86]

[85] UNEP (2024, Global Environment Facility).

[86] ICMA Group (2023, Labelled Bonds).

Both government issuers and companies are increasingly using this debt financing instrument to finance the **expansion of renewable energies**, their own climate-related transformation (**green bonds**), the construction of healthcare or educational facilities (**social bonds**) and affordable housing. In the case of sustainability-linked bonds (SLBs), the financial or structural characteristics (i.e., coupon, maturity, repayment amount) depend on whether the issuer achieves predefined ESG targets within a predefined timeframe.

There are currently three main international institutions influencing **the standard setting** of the labelled bonds market:

1. the *International Capital Market Association (**ICMA**),*
2. the *Climate Bonds Initiative (**CBI**),*
3. and *Green Bond Standard* of the *European Union (**GBS**).*

1. The *ICMA*, which dominates the market, is a self-regulatory organization and trade association for capital market participants with a focus on fixed income markets. Stated objectives are to promote high standards of market practice, appropriate regulation, trade support and education[87]. In 2021, over **98 % of all labelled bonds were in compliance with the *ICMA* Principles**.[88]
2. The *CBI* is an international non-profit organization which intends to develop a large and liquid green bond market to mobilize and reduce the cost of capital for the transition to a low-carbon economy. In addition to certifying their own standard, they engage with investors, regulators and other stakeholders and provide market intelligence and research[89]. The guidelines of these two institutions have become the market standard used by issuers to self-label their bonds. However, as the definition of a positive environmental or social outcome is partly subjective, up to **21 % of bonds may be subject to greenwashing**, with SLBs being criticized for having unambitious targets.[90] As a result, there is a growing number of **external reviewers**, such as *Vigeo Eiris, Cicero* or *ISS-Oekom*, that evaluate labelled bonds: both their pre-issuance framework and their post-issuance implementation and **use of proceeds**[91].
3. The **EU** has also introduced a voluntary **Green Bonds Standard**, based on the *EU taxonomy* to define green economic activities, which will apply from **December 21st, 2024**, to address greenwashing allegations and increase comparability and transparency[92]. The regulation establishes a registration system and supervisory framework for external reviewers under the *European Securities and Markets Authority (ESMA).*[93]

5.3.2 Development and Future of the Labelled Bonds Market

The market for labelled bonds has grown rapidly in recent years. In 2007, the *European Investment Bank* issued the first labelled bond under the name **Climate Awareness Bond.**[94] Since then, the market volume has grown to USD 30 billion in 2014[95] and more than USD 3.4 trillion today.[96]

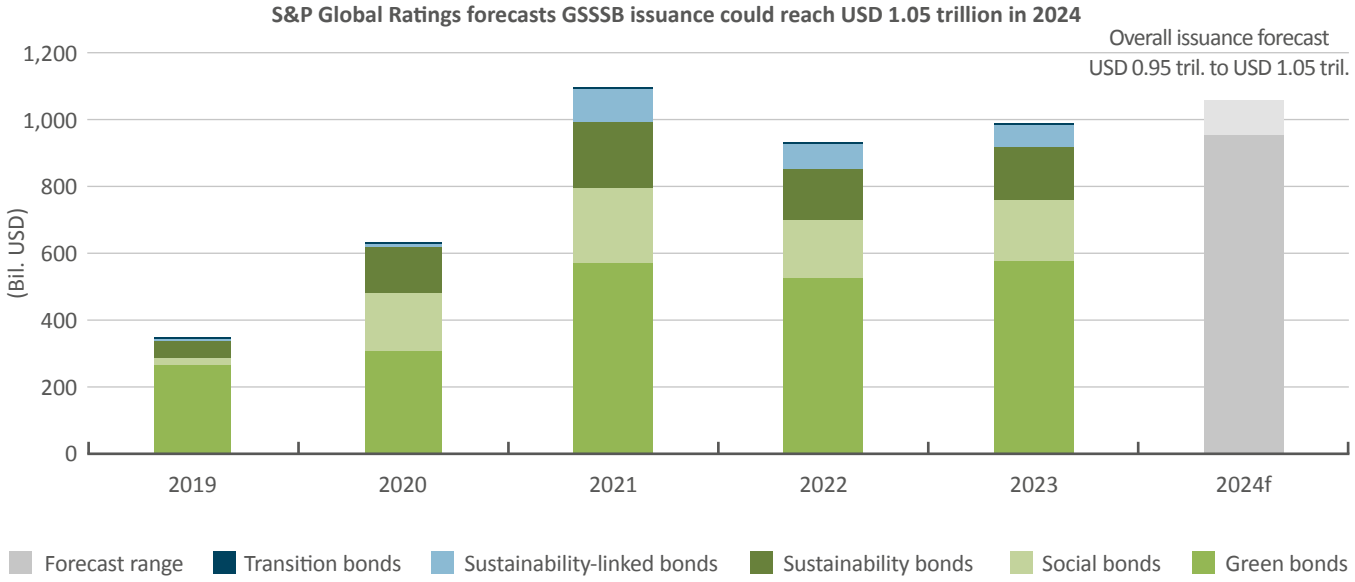
In **2024**, issuance is expected to reach **USD 1 trillion and 14 % of the total market**, while macroeconomic conditions and interest rate hikes are hindering greater expansion. With USD 147 billion of new sustainable bonds and loans, January 2024 was the strongest January on record for new sustainable debt transactions; green bonds grew 25 % year-over-year to USD 76 billion.[97] To date, labelled bonds have been issued in more than **80 countries and in 40 different currencies** (42 % priced in euros), mainly from the US, France and China.[98]

Green bonds dominate the market for labelled bonds, although other types are increasing their market share and are expected to become more relevant in the near future. In 2022, **two-thirds** of the volume of green bonds **originated in developed markets**, although China was the largest issuer of

87 ICMA Group (2024, Organization).
88 ICMA Group (2024, Principles).
89 Climate Bond (2024, Organization).
90 McNeil (2024, Impact Market).
91 Phillips (2021, Labelled Bonds).
92 Ziegenbalg (2024, Green Bond Standard).
93 European Council (2023, European Green Bonds).
94 EIB (2024, Climate Bond Awareness).
95 MSCI (2024, Labelled Bonds).
96 Malich et al. (2023, Labelled Bonds).
97 SEB (2024, Green Bond).
98 Climate Bonds Initiative (2024, Data Platform).

green bonds. While labelled bonds can be issued by all types of issuers in the debt capital markets, the market is currently dominated by supranational, sovereign and agency issuers (51 % in 2022), followed by non-financial corporates (26 %) and financial institutions (23 %).[99] About 80 % of the deals were smaller than USD 100 million, but benchmark-sized deals with tickets of USD 500 million and above accounted for about 70 % of the labelled bond volume.

Figure 11: Global Labelled Bond Market Development and Estimation for 2024



Excludes structured finance issuance. f--S&P Global Ratings forecast. GSSSB--Green, social, sustainability, and sustainability-linked bonds.

Source: Cochelin et al. (2024, Sustainable Bond Issuance) [100]

In the first half of 2023, average **oversubscription was 5.4 times for USD-denominated green bonds** and 3.2 times for EUR-denominated green bonds, compared with 2.4 times and 2.7 times for standard bond equivalents.[101] Some studies even show that green bonds often even have a **green premium or "greenium"** – a higher valuation compared to conventional bonds. An *MSCI* analysis of USD-denominated corporate bonds issued in recent years found that they have consistently traded at spreads 1-6 basis points tighter than their issuers' yield curves would imply. Labelled bonds issued by companies in the **utilities sector** showed the largest "greenium" relative to other sectors.[102]

Labelled bonds are in high demand, according to **Sean Kidney, CEO of the *CBI***:

Green and other labelled bonds carry huge demand, are regularly oversubscribed, and deliver results for issuers even as tough times cause fixed income to falter. As for investors, they're throwing themselves at labelled bonds which offer transparent debt fit for the net-zero future.[103]

[99] Malich et al (2023, Labelled Bond Issuance).

[100] Cochelin et al. (2024, Sustainable Bond Issuance).

[101] Caroline (2023, Green Bond Pricing).

[102] Malich et al. (2023, Greenium).

[103] Harrison (2023, Green Bond Pricing).

Currently, only a small, though growing, portion of the proceeds from labelled bonds is used to protect or restore biodiversity. The dominant UoP categories are still **energy, buildings and transport**, with a share of around 80 %. Around **16 % of labelled bonds included terrestrial and aquatic biodiversity conservation** as an eligible UoP in 2023, up from 5 % in 2020. As of January 2024, approximately USD 480 billion of outstanding bonds included biodiversity conservation as a potential UoP.[104]

Half of the money spent went to forestry projects, 23 % to terrestrial nature conservation projects and 18 % to sustainable agriculture. And only 5 % went to marine biodiversity.[105] A larger proportion of labelled bonds finance related target projects, such as sustainable water management (24 %) and pollution prevention and control (20 %). Especially supranational institutions, notably the ***World Bank* and the *EIB*** are the main issuers of a significant amounts of biodiversity-related bonds mainly to finance projects developing regions.

- A particularly interesting segment could be labelled bonds that finance **renewable energy projects while having a positive impact on biodiversity**, such as the **Zambian green bond**, which aims to reduce the use of wood fuels and deforestation by financing solar energy projects.

5.3.3 Challenges and Solutions of Biodiversity Bonds

Today, the **lack of scalable measurement tools and impact metrics** is the biggest obstacle to the rapid development of labelled bonds to finance biodiversity conservation and restoration. As noted in chapter 6, the collection and availability of biodiversity data is a challenge. **There is no global consensus** on measurement standards, and clear rules are only now being developed.

Both the **measurability of ecosystem interdependencies** and the negative **impacts of economic** activities need to be significantly expanded. So far, few companies publicly disclose or measure their environmental footprint, and when they do, the metrics are highly variable. However, the **regulatory requirements of the *CSRD* and *SFDR*** (see chapter 3) will dramatically change this. From 2024, the publication of this information will be mandatory.

A positive development in this regard is a guidance document from the ***Impact Reporting Working Group***, a group established by the *ICMA*. The document proposes a **harmonized impact reporting framework** for biodiversity projects. It provides core quantitative indicators as well as reference reporting templates and benchmarks that reflect relevant international standards.[106]

Moreover, the ***International Finance Corporation*** *(IFC* – a member of the *World Bank Group*) has published a ***Biodiversity Finance Reference Guide*** that provides a granular description of investments, activities, and project components to identify eligible UoPs that can qualify for biodiversity finance. These may have biodiversity conservation or restoration as their primary objective, seek to generate biodiversity co-benefits, or support nature-based solutions.

All projects listed must be consistent with the **environmental objectives of the *ICMA* Green Bonds** Principles. The principles list biodiversity as an eligible UoP, but do not provide a detailed description of projects that fit this category. The reference guide aims to fill this gap by providing an indicative list of investment activities.[107]

Beyond that, *ICMA* has partnered with *IFC*, the *UN Global Compact,* the *United Nations Environment Program Finance Initiative (UNEP FI)*, and the *Asian Development Bank (ADB)* to develop a **global practitioner's guide to blue bonds** financing the sustainable blue economy. It builds on existing market standards and provides market participants with criteria, practices, and examples of blue bonds.[108]

[104] Sustainable Fitch (2024, Financing Biodiversity).

[105] Webb (2023, Biodiversity Bonds).

[106] ICMA Group (2020, Impact Reporting).

[107] IFC (2023, Bildiversity Finance).

[108] ICMA Group (2024, Blue-Themed Bonds).

- **Risk-sharing and guarantee mechanisms** can be another option to address concerns about the perceived low returns and higher risks associated with biodiversity projects.
- In addition, certain activities also have the potential for **income generation based on natural capital**.
- Examples include financing more **sustainable production of raw materials**, measures against environmental pollution (i.e. plastic), financing NbS such as coastal protection through mangroves, or nature-based filtration systems for water purification.

Blue Bond in Southeast Asia – Combat Plastic Pollution and Preserve Water 2022[109]

In May 2022, the largest bank in the Philippines issued the first private sector Blue Bond in Southeast Asia worth USD 100 million, with an investment from the *IFC*. This issuance will expand financing for projects such as wastewater treatment, plastic recycling, or sustainable seafood processing that help prevent marine pollution and preserve clean water resources. Solid waste management and marine plastics are key issues for the Philippines, threatening several elements of the blue economy as well as urban public health. According to a *World Bank* study, the country is the third largest contributor with an estimated 750,000 metric tons of mismanaged plastic entering the ocean each year.

Another challenge to facilitating labelled bonds for biodiversity finance is the **relatively small size of biodiversity projects**.

To address this challenge, the coordination and aggregation of smaller projects and multiple value chains to achieve sufficient scale while demonstrating positive impact could be supported by local, regional, and national governments and private stakeholders.

It is essential that international partners from developed countries provide adequate **technical support and capacity building**. This is particularly true for some less developed countries that are also known for their biodiversity. Local authorities in these countries need to be empowered to develop more bankable projects that meet the requirements for green or biodiversity bonds. Ongoing and future international technical cooperation programs on marine, forest and landscape restoration are essential to provide the knowledge and measurement capabilities needed for financing.[110]

Blue Bond: Action Plan for Healthy Oceans, *ADB* 2021

In September 2021, the *Asian Development Bank (ADB)* issued its first-ever dual-tranche blue bonds to finance ocean-related projects in Asia and the Pacific. The issuance of the AUSD 208 million 15-year and NZUSD 217 million 10-year bonds is part of *ADB*'s Action Plan for Healthy Oceans and Sustainable Blue Economies, which aims to catalyse sustainable investment by committing at least USD 5 billion in investments and technical assistance by 2024. The proceeds will fund projects that improve ocean health through ecosystem restoration, natural resource management, sustainable fisheries and aquaculture, coastal pollution reduction, circular economy, marine renewable energy, and green ports and shipping.[111]

- Labelled bonds have a bright future: Supported by a marked increase in public awareness and global initiatives for the conservation and revitalization of nature, such as the *Kunming-Montreal Global Biodiversity Framework*, a significant **increase in emissions** by national development banks and supranational institutions is to be expected.
- The capital-intensive development of nature conservation projects and the preservation and restoration of biodiversity are the responsibility of countries and regions. **State-supported financing will be a key factor for successful implementation**.
- At the same time, the success story of labelled bonds shows that the financing of climate and nature conservation measures also by companies is expected to be **highly valued by investors**.

[109] IFC (2023, Green And Social Bonds).

[110] Chahine et al. (2020, Green Bonds).

[111] ADB (2024, Blue Bond).

5.4. Private Markets – Innovation and Tech Solutions in Venture Capital

5.4.1. Market Development of Impact and Nature Venture Capital (VC)

The integration of **sustainability factors into investment decisions** is also gaining momentum in the private market segment. Biodiversity considerations are becoming an integral part of investment strategies, prompting investors to assess the impact of their portfolios on the natural world.[112]

Investing in biodiversity-related products and technical solutions within the private markets offers a unique opportunity for investors to align their financial goals with positive nature and biodiversity impact.[113]

- The medium to **long term investment horizon** of private markets is particularly suited to capitalizing on the potential opportunities and returns from ecosystem services and biodiversity associated with restoration and enhancement.
- At the same time, **technology-based innovations offer high-yield investment opportunities** that also attract yield-focused investors. The current market for biodiversity-focused investments in the private markets is experiencing **increased interest**.[114]

There are exciting **technological breakthroughs** with the opportunity to create interesting investment opportunities. **Early-stage private companies** are expected to be among most of the fast-growing disruptors to drive innovation in the upcoming years. Therefore, to **gain access** to those companies and investment opportunities, investing in private markets is unavoidable.[115]

The push for biodiversity-enhancing initiatives is driven not only by ethical considerations, but also by the recognition that companies with **strong environmental practices are better positioned for resilience in the face of global challenges.** Nature-related VC and Private Equity investments can offer a unique opportunity for investors to contribute to positive environmental outcomes while potentially generating financial returns.

5.4.2. Biodiversity-related Topics in the VC Markets

Regenerative agriculture has become a key element in the pursuit of eco-friendly and sustainable practices. The idea of regenerative agriculture is that **farming should not only produce food but also benefit the biodiversity** of the land, as well as its water and soil quality.

Dissimilar to organic farming, ***regenerative agriculture*** allows the restricted use of chemical fertilizers and pesticides. Although definitions may sometimes vary, practices normally include **minimizing ploughing** to reduce soil disturbance and **annual rotation of crop types on the same area** to increase nutrient diversity and minimize pests.

According to Mark Durno, former farmer and managing partner at venture capital group *Rockstart*,

Regenerative farming is a different way of thinking about the land, and it is about thinking of the land as something, that is alive.[116]

[112] Tidd (2022, Lazar Asset Management).

[113] Finance for Biodiversity Foundation (2024, Measurement Approaches).

[114] Flammer (2023, UNPRI).

[115] Schaeffer (2023, Private Market Growth).

[116] Financial Times (2023, Regenerative Agriculture).

Big food companies such as *Nestlé, Danone* and *Unilever* have picked up this term of regenerative agriculture and therefore it has become a common mention in their sustainability plans.

- VC in the field of regenerative agriculture offers the perspective to achieve financial gains while actively contributing to global change.

It is driving the **development and implementation of innovation** in regenerative agriculture and in the **sustainable marine economy**. In particular, the funding of technology start-ups, combined with a growing awareness of environmental issues, has broadened its scope to include innovation focused on the conservation and restoration of biodiversity.

- Growing interest and government-backed innovation programs, such as the *European Commission's* ***BlueInvest*** *initiative*, are creating a new ecosystem of young companies developing solutions for nature, agriculture, and oceans.
- Investors are also increasingly willing to provide these impact start-ups with the necessary funding.[117]

BlueInvest – European Commission[118]

The ***BlueInvest Platform*** is an accelerator portal which serves as a gateway for investors to explore compelling opportunities in technology venture capital with a special focus on the blue economy. Launched by the E*uropean Commission* in 2019, this distinct EU initiative connects forward-looking investors with cutting-edge technology ventures in the maritime, fisheries, and aquaculture sectors. By providing **comprehensive information** on current developments and innovative projects, they emphasize the potential for technology venture capital investment and highlight the key role of advanced technologies in shaping the future of the blue economy.

The strategy of *BlueInvest* is both **sector and technology driven**. This includes dedicated blue funds as well as broader funds that allocate a portion of their portfolio to the blue economy. This strategic approach ensures a **diverse range of investment opportunities** and promotes the integration of cutting-edge technologies in different sectors such as agriculture, blue biotechnology, conservation and regeneration, fisheries, shipbuilding and refitting, shipping and ports, and water management. renewable energy, blue tech and ocean observation, coastal and maritime tourism, environmental protection, etc. Since its launch 226 businesses have benefited from the platform. Additionally, more than 80 beneficiaries have received qualified introductions to investors.

According to data provider *Dealroom*, between 2021 and 2023, VC funds have financed USD 1.4 billion capital for **regenerative agriculture start-ups**. This marks a **46 % increase** in comparison to the previous three years.[119] At present, the number of VC funds investing in the blue or green economy is still relatively small, but growth is promising, according to a report by the *BlueInvest initiative*.

Through targeted investments in blue and green technologies, investors can not only to yield sustainable returns but also to promote soil health, optimize water usage, and reduce carbon footprints and foster the restoration of nature and ocean.

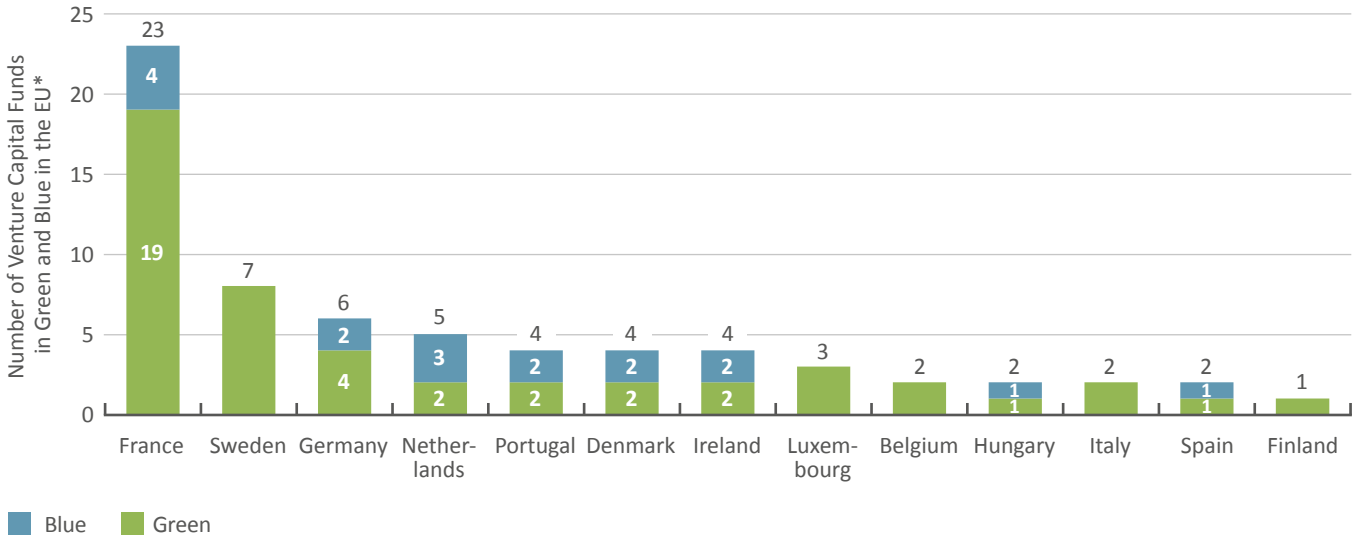
Companies focusing on regenerative practices often **lead the way in innovative technologies** that make agriculture and fishing/aquaculture more efficient and environmentally sustainable. Innovative business concepts and technologies allow investors to invest in companies that consider the carbon footprint throughout the supply chain in regenerative cultivation and the use of environmental resources. Companies that source raw materials responsibly and implement environmental practices in their supply chains contribute to the overall health of ecosystems.

[117] BlueInvest (2024, Community).

[118] BlueInvest (2024, Community).

[119] Pratty (2024, Regenerative Agriculture).

*Figure 12: Number of Venture Capital Funds in Green and Blue in the EU**



*France has investors in the green space that have multiple funds launches (such as Mirova, Omnes and Soffinova). Same happens in the Netherlands, where Aqua-Spark has multiple blue dedicated funds.

Source: BlueInvest (2024, Investor Report) [120]

5.4.3. *Climate & Biodiversity Innovation and Technologies: Carbon Sequestration and Biotech*

From **precision farming practices** to **eco-friendly packaging solutions**, start-ups promoting sustainability at every stage help reduce emissions associated with conventional agricultural processes.

- Investing in start-ups that specialize in (green) **carbon sequestration technologies** within the regenerative agriculture space is a promising endeavour.[121]

These technologies focus on **capturing and storing carbon in the soil**, aiding in the fight against global warming.

Furthermore, investments in VC can be directed towards start-ups promoting **conservation agriculture** practices.

- These initiatives **focus on minimal soil disturbance**, cover cropping, and crop rotation, which not only enhance soil health but also contribute to carbon sequestration, making them attractive options for environmentally conscious investors.

Investing in carbon offset technologies within the regenerative agriculture sector through VC not only aligns with global environmental goals but also positions investors at the forefront of sustainable innovation. By supporting companies that actively contribute to carbon sequestration and emissions reduction, ***investors can make a tangible impact while realizing the financial potential of this rapidly evolving and critical sector***.

Another promising avenue for carbon sequestration is through ***blue carbon sinks***, which are among the most efficient carbon sinks but also among the fastest disappearing ecosystems on the planet. They include **estuaries, salt marshes, shelf seas, seagrasses, and mangroves**, and provide ecosystem services worth an estimated USD 25 trillion annually.[122]

[120] BlueInvest (2023, Investor Report).

[121] Woolnough (2023, Carbon Pulse).

[122] Nellemann et al. (2009, Blue Carbon).

Yet blue carbon markets and start-ups are underdeveloped and underfunded, despite growing corporate demand for this limited supply of verified credits.[123] The diverse start-up field[124] ranges from dropping mangrove seeds from drones[125] to combining fishponds with mangroves for investible regenerative aquaculture farms.[126]

Furthermore, the **advanced sensor technologies** are playing a crucial role in monitoring and collecting data on biodiversity. These **sensors, often powered by AI,** enable real-time tracking of ecosystems, helping scientists and conservationists make informed decisions about habitat management and protection. The investments often focus on development of cutting-edge technologies such as satellite imaging, sensor networks, and data analytics to monitor and manage ecosystems. Investors can support the development and deployment of these technologies for commercial gain and positive environmental impact.

- Most **data-driven approaches** allow for targeted interventions, optimizing resource allocation and increasing the overall impact of conservation efforts.
- **Blockchain technology** is being leveraged to enhance transparency and traceability in conservation efforts. Through decentralized and tamper-proof ledgers, investors can track the impact of their investments, ensuring that funds are used efficiently and effectively for biodiversity conservation projects.
- **Biotechnology solutions**, such as **genetic engineering and synthetic biology**, are being also explored to aid in ecosystem restoration. This includes the development of **resilient plant and animal species** that can thrive in degraded environments, contributing to biodiversity preservation.

The **biotech public markets** had a difficult time in the past years. The *S&P Biotechnology Select Industry* dropped down by over 50 % from its peak in February 2021 as it entered the fourth quarter of 2023. During the first three quarters of 2023 just 30 biotech startups have completed an IPO in the, in comparison to 114 IPOs in 2021. Overall, biotech IPO funding has decreased, with just USD 3.4 billion raised in the first three quarters of 2023, down from USD 16 billion in the first three quarters of 2021.

The answer to this hard environment is that over 250 biotech start-ups have started layoffs in 2022 and 2023. Therefore, many businesses have simplified their project pipelines to safeguard their accessible capital resources. In this challenging environment, venture capital funding has offered a much-needed lifeline for biotech research. **Financing by VC funds has held constant** and raised above pre-pandemic levels, nevertheless it has fallen since its peak in 2021. In 2022 VC funds invested more than USD 22 billion in early and late-stage rounds. The decrease in the amount of funding is mainly due to a decline in the number of deals, while the median deal size has remained the same. **Investors are still primarily focused on innovation**, with Series A funding rounds accounting for nearly half of all deals.[127]

While alternative investments and biodiversity hold great promise, challenges such as **regulatory uncertainty, scalability issues and the complex nature of conservation projects** remain. However, the investment industry's commitment to driving positive change and the continued development of innovative technologies suggest a bright future for private market contributions to biodiversity conservation.

- By **strategically selecting** private market investments that prioritize biodiversity, investors can play an active role in conserving natural habitats, protecting endangered species and promoting sustainable practices. This not only **aligns with global environmental goals**, but also provides a way for investors to generate returns while **making a positive impact** on the planet.

The convergence of VC, technology and biodiversity marks a pivotal moment in private markets. As investors recognize the **potential for both financial returns and environmental impact**, the landscape is ready for further innovation and collaboration. By fostering the development of cutting-edge technologies and supporting conservation initiatives, the investment industry can become a powerful force in safeguarding the planet's biodiversity for generations to come.

[123] World Ocean Initiative (2022, Blue Carbon).

[124] Blue Natural Capital (2024, Accelerator Fund).

[125] Distant Imagery (2024, Drone Technology).

[126] Blue Natural Capital (2024, Sustainable Seafood).

[127] McKinsey (2023, Biotech VC Funding).

5.5. Multi-use & Green Infrastructure – Economic Basis and Large-scale Opportunity

Infrastructure is considered a **key factor in a country's economic development**, which is most often promoted through direct and indirect fiscal growth stimuli. **Large investors have invested heavily** in infrastructure in recent years. The long-term stable and predictable income streams, the size of the investment and the favourable risk/return profile have made infrastructure one of the most popular asset classes.

Moreover, infrastructure is one of the few asset classes that offers **direct access and investment impact to climate engagement**, such as renewables. At the same time, infrastructure is also critical to achieving the UN SDG and is recognized as such in **SDG 9**: **"Industry, innovation and infrastructure; build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation"**.

Unfortunately, political and economic interests are **sometimes in direct conflict with nature conservation**, particularly in the development of large-scale infrastructure projects. Additionally, **infrastructure planning is a long-term and costly process**. At the institutional level, ministries, planning commissions, city councils, the national finance ministry, banks and international donors are involved.

Biodiversity often overlaps with the assessment of infrastructure needs if the needs assessment is holistic and systemic. Therefore, some policymakers, as well as the business community, are lately moving to better align themselves with market realities and **to assess, minimize or avoid the environmental impacts** of infrastructure projects. Investors are increasingly focusing on the environmental impact of their investment and are demanding responsible planning and implementation.[128]

The scalability and favorable risk-return profile of **infrastructure** as an asset class may represent one of the **most significant investment opportunities** in the efforts to protect and rebuild biodiversity. The scale and impact of infrastructure projects are enormous, so the potential for change is equally great if they are delivered in an environmentally responsible way.

Meanwhile, new **innovative combined solutions** can even enable infrastructure to **make a net positive** contribution to biodiversity.

5.5.1. Renewables plus Biodiversity = "Multi-use Infrastructure"

Renewable energy infrastructure is not only one of the most important tools in the fight against climate-damaging fossil fuel energy production, but also one of **the most important, popular and largest asset classes for institutional investors.** Growth and need continue unabated. Demand has even accelerated in the last two years, which have been marked by geopolitical crises and tensions. In its latest energy report, the *Energy Information Administration (EIA)* notes that both the recovery after the COVID19 crises as well as the response to the global energy crisis has provided an important stimulus for investing in clean energy.

The new analysis shows how the **sharp fluctuations in fossil fuel markets** resulting from the Russian incursion into Ukraine have **spurred the deployment of a range of clean energy technologies**, despite the short-term disruption to oil and gas supplies.

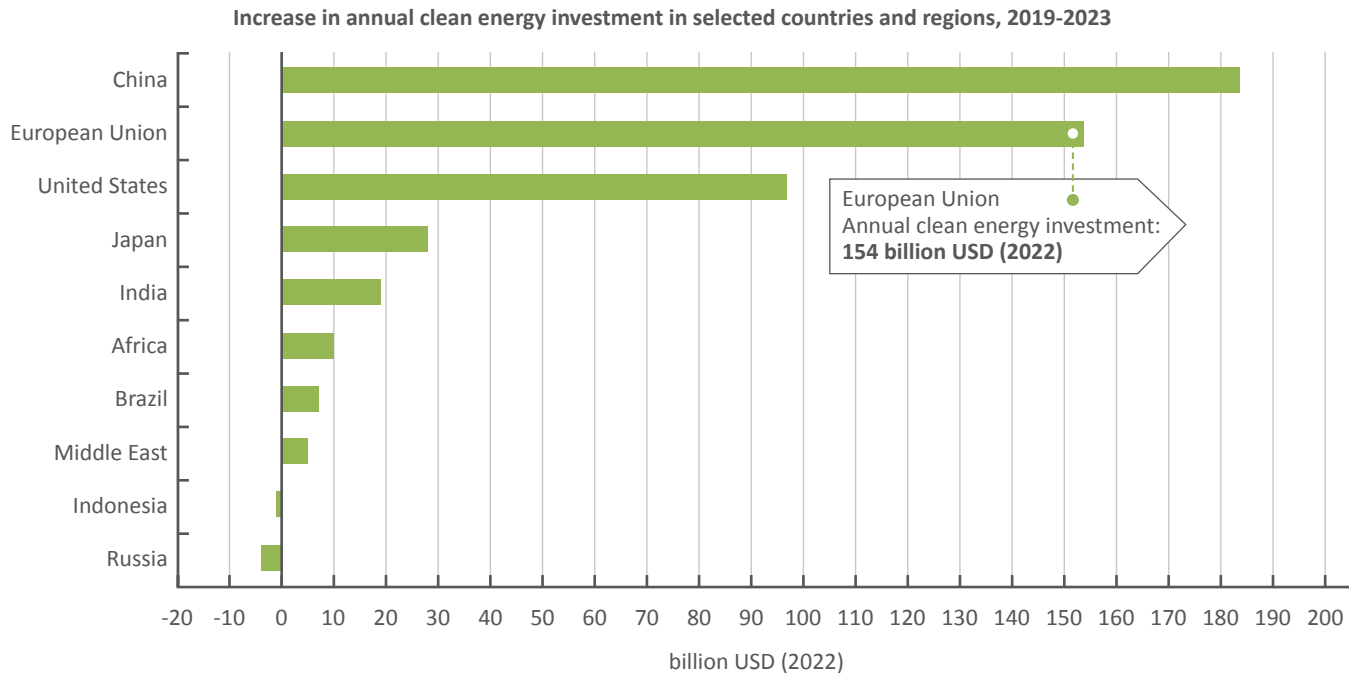
About **USD 2.8 trillion will be invested in energy in 2023**, according to *EIA* estimates. More than **USD 1.7 trillion will be spent on clean energy**. This includes renewables, nuclear, grids, storage, low-emission fuels, efficiency, renewables, and end-use electrification.

The rest, just over USD 1 trillion, will be spent on unabated fossil fuel supply and power generation, of which about 15 % is for coal and the rest for oil and gas. For every USD 1 spent on fossil fuels, USD 1.7 is now spent on clean energy. Five years ago, the ratio was 1:1. Investing in clean energy has been driven by several factors. These include improved economics at a time when the price of fossil fuels has been high and volatile.[129]

[128] Perera et al. (2017, Biodiversity Infrastructure).

[129] International Energy Agency (2023, Energy Investments).

Figure 13: Expenditure on Clean Energy Globally



Source: International Energy Agency (2023, Clean Energy Investments) [130]

So-called novel multiple-use projects can be a promising way to improve biodiversity in combination with clean energy, which not only contributes to climate change mitigation but also has a positive impact on ecosystems. Considering environmental protection measures and multiple-use projects, there is reason to be optimistic about channelling even higher levels of investment into nature restoration, given the rapid expansion of renewable energy generation capacity in response to policy changes.

- The huge amounts of investment that are also being made in the more far-reaching segments of the energy transition can support many opportunities to significantly reduce the negative impacts of the energy industry.
- Improving efficiency, reducing harmful emissions, avoiding waste and preventing pollution will have a direct positive impact on local biodiversity.

There are two main perspectives on the influence and impact on biodiversity and when investing in infrastructure:

1. **avoiding and reducing negative impacts** on nature in the construction and use of infrastructure, and on the contrary,
2. using infrastructure in innovative **multi-use ways** for additional economic value and **positive impacts on biodiversity.**

These are the measures for which there is already legal requirements (e.g. *CSRD*) and which are also the subject of economic subsidies. The basic impact of construction on nature must be mitigated, and compensation and protection measures could be mandatory. **In the future, both investors and regulators may require mandatory compensation and mitigation measures.**

[130] International Energy Agency (2023, Energy Investments).

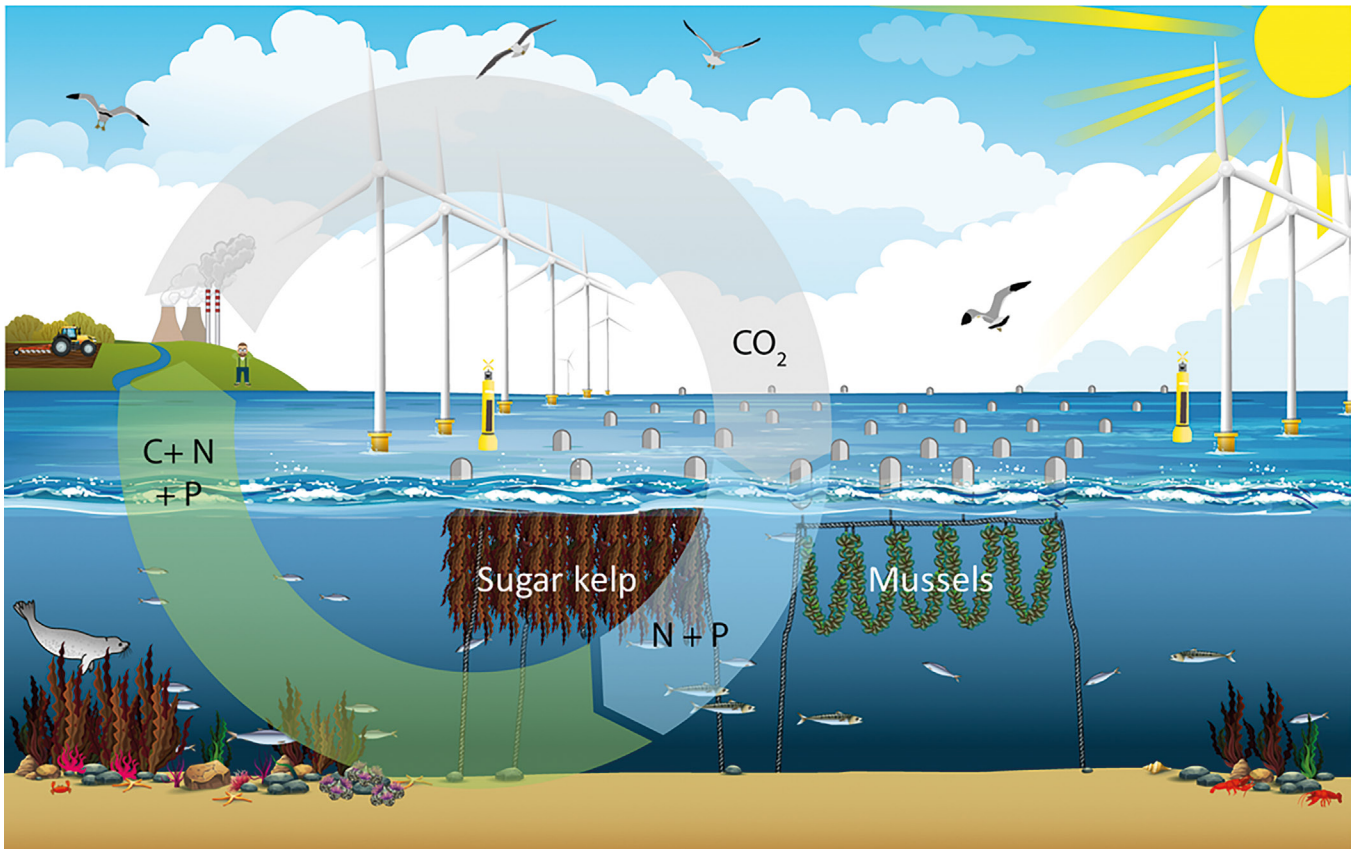
Examples for Multi-use

1. Offshore Windfarms with Low-Trophic Aquaculture

Combining **offshore wind farms with low-trophic aquaculture** could provide sustainable energy, nutritious seafood and restorative ecosystem services by capturing and using nutrients and carbon. A recent published scientific study analysed the economic and environmental potential of multiple-use offshore wind farms. The results were astonishing, as the positive effects as carbon capture, for the restoration of biodiversity, as well as a source of multiple revenues, are evident.

Figure 14: Conceptual Figure of Multi-Use Combining Wind Farms with Low Tropic Aquaculture

Multi-use in offshore wind farms with farming of blue mussels and sugar kelp can deliver emission free energy, nutritious seafood, and positive ecosystem services through emission (CO_2 and nutrients) capture and utilization.



Source: Maar et al. (2023, Offshore Windfarms) [131]

A **multi-use of offshore wind farms** with **low-trophic aquaculture** could provide **sustainable energy, nutritious seafood,** and restorative ecosystem services through nutrients and carbon capture and utilization. A recent study analysed that in a transition zone between the sea and brackish water, an allocation of **only 10 % of the projected wind farm** areas for the aquaculture of mussels and sugar kelp in the transition zone between the North Sea and Baltic Sea could yield **18 tonnes fresh weight ha-1 per year**. **Total carbon captured** and harvested from seaweed biomass and mussel shells would equal **40 % of the carbon dioxide emissions from the Danish agricultural sector**. Furthermore, global aquaculture production is projected to **increase by 132 %** compared to current production.

[131] Maar et al. (2023, Offshore Windfarms).

With technological and regulatory challenges still to be addressed, these findings demonstrate a **vast potential of multi-use in offshore areas**, which can generate blue biomass with fewer user conflicts, while mitigating eutrophication and climate change, thereby supporting multiple global sustainable development goals.

In another two-year project supported by the *European Commission*, an additional study has shown that the cultivation of algae and mussels in the Belgian North Sea within offshore wind farms is biologically feasible. The economic realisation depends on solving some technical challenges, but could be a feasible and very advantageous solution, just like the use of algae mentioned above. **The additional source of income from the cultivation of marine flora and fauna has a clear economic advantage. It also enables the sensible use of marine areas within offshore wind farms.** The cultivation of algae and other marine resources also have excellent properties for the restoration of a healthy marine ecosystem.[132]

In 2023, a 10 hectare demonstration farm will be launched off the Dutch coast to serve as a blueprint for the entire North Sea. The "**North Sea Farm 1"** project, led by the non-profit organization *North Sea Farmers (NSF)*, aims to demonstrate the potential of growing algae in offshore wind farms and how the crops can help reduce CO_2. The aim is to have a minimum production of **6,000 kilograms of fresh algae** in the first year of operation. Potentially, up to **85,000 jobs** could be created simultaneously in the European seaweed sector if similar projects were replicated across the North Sea, using the space between wind farms. These jobs would range from cultivation to the production and sale of algae-based products.[133]

2. Agri-PV: Photovoltaic with Agricultural Use

Another multi-use renewable energy opportunity is "**Agri-PV"**.

Agri-PV increases **land efficiency and enables the expansion of PV output**. At the same time, **fertile farmland can be preserved for agriculture or combined with the creation of species-rich biotopes.** The *Fraunhofer ISE Institute* is already actively involved in various practical international implementation projects and has found that Agri-PV technology has developed very dynamically in recent years and is already widespread in almost all regions of the world. The installed **capacity of Agri-PV has increased exponentially** from around 5 MWp in 2012 and around 2.9 GWp (2018) to more than 14 GWp in 2020, with government support programs in Japan (since 2013), China (around 2014), France (since 2017), the USA (since 2018) and most recently Korea.[134]

Agri-photovoltaics (Agri-PV) refers to the simultaneous use of land for agricultural crop production (photosynthesis) and PV electricity production. In terms of the intensity and type of agricultural use, as well as the additional costs of constructing PV systems, Agri-PV covers a broad spectrum. This spectrum ranges from the **cultivation of special crops** and **intensive arable farming** with special PV mounting systems, to **extensive grazing** with only marginal adaptations on the PV side.

[132] European Commission (2019, Offshore Mussel Culture).

[133] Erneuerbare Energien (2023, Algae Farm).

[134] Trommsdorf (2024, Agri-Photovoltaik).

Agri-PV: Fruit Growing[135]

Agri-photovoltaics as a resilience concept for adapting to climate change in fruit growing: The agricultural sector is facing new challenges. In the wake of climate change, strategies must be developed to avoid negative effects on harvests. Fruit growing in Germany is already affected by the consequences of climate change: rising temperatures, changing rainfall patterns and increasingly frequent extreme weather events such as hail and heavy rainfall. Commercial fruit growers are therefore increasingly using hail protection nets and films to prevent quality and yield losses. The "APV fruit growing" project aims to investigate the extent to which Agri-PV can fulfil this protective function in apple growing, which system design makes sense for this crop and what effect the PV system has on crop yields.

The aim of the project is to **increase resilience in fruit growing and to utilize land in a dual and resource-efficient manner**. This can counteract land use competition between ground-mounted photovoltaic systems and agriculture. The project is financed by the German *Federal Ministry of Food and Agriculture (BMEL); Ministry for Climate Protection, Environment, Energy* and *Mobility of the State of Rhineland-Palatinate (MKUEM)* and will be run until 2025 in Bavaria, Germany.

Figure 15: Agri-PV Experimental Set-Up

Source: Fraunhofer ISE (o.A., Agri-PV) [136]

[135] Steinhüser (2024, Fruit Growing).

[136] Fraunhofer ISE (o.A., Agri-Photovoltaik).

5.5.2. Green Infrastructure

In addition to multi-use infrastructure there is another category of infrastructure called **"Green Infrastructure" or "NbS" which has biodiversity and ES integrated in its strategic development process.**

Green Infrastructure is a strategically planned network of natural and semi-natural areas, along with other environmental features, designed and managed to provide a wide range of ecosystem services. These services include water purification, air quality improvement, recreational space provision and assistance with climate mitigation and adaptation. Developing green infrastructure can improve the quality of the environment, the condition and connectivity of natural areas, and citizens health and quality of life. It can also support a green economy and create job opportunities.[137]

Examples of Green Infrastructure include urban parks, green roofs, green walls, rain gardens, wetlands, forests and green corridors. These elements work together to provide ES such as biodiversity conservation, air and water purification, flood mitigation, climate regulation and recreational opportunities.

- Green infrastructure provides **habitat for a diverse range of plant and animal species**, promoting biodiversity and ecosystem resilience.
- By preserving natural areas and creating **green spaces within urban environments**, Green Infrastructure helps to support wildlife populations and maintain ecological balance. Unlike traditional grey infrastructure, which typically involves heavy engineering and construction, green infrastructure emphasizes working with nature to achieve sustainable outcomes.
- Concluding the portrayed frame of Green and Grey Infrastructure, embracing green infrastructure and NbS can also have **positive effects on public health**. By incorporating green spaces and natural elements into urban areas, such as parks, gardens, and tree-lined streets, people can enjoy improved air quality, reduced noise pollution, and **increased opportunities for physical activity**.
- Hence, green infrastructure can help **regulate urban temperatures**, mitigating the urban heat island effect and reducing the need for energy-intensive cooling systems. By prioritizing green infrastructure, communities can create healthier and more livable environments for their residents.

5.6. "Real Assets" – Innovative Investing in Land: Regenerative Agriculture & Forestry

Typically, ***"real assets"*** are defined as investments in non-liquid assets. In this study, the term real assets refers to direct investments in land and forestry as used by many institutional investors.

5.6.1. Sustainable Forestry – Carbon Sequestration and Restoration of Ecosystems

Forestry investments have become increasingly popular in recent years, particularly among institutional investors, as they offer an **attractive risk/return profile** and the opportunity to diversify the investment. This allows investment **risks to be spread** further.

The **correlation** with other investments traditionally made by institutional investors is **low**, especially in times of crisis, as forests grow completely independently of economic developments and the financial markets. In addition, timber price fluctuations can be offset by active management. In times of low timber prices, the trees are simply left standing and, depending on the region, can grow by up to 10 % in volume and thus also in value ("store on the stump").

[137] European Commission (2020, Green Infrastructure).

Carefully selected forestry investments can also have a **positive impact** on environmental, social and governance issues. Storing CO_2 in wood, a renewable resource, helps to combat climate change.

However, the acquisition of forest land requires **extensive expertise and management resources**. Several asset managers have set up vehicles for this purpose, in which the land is spread over a number of regions and the management of the use of the forest is carried out by appropriate service providers.

If the aim is to have a positive impact on nature, it is important to note that the use and economic management of the forest also needs careful consideration and monitoring. **Extensive forest management can lead to damage to the ecosystem** in the case of pure monocultures or the use of tree species that are alien to the region. The carbon storage capacity of forests should not be the only positive argument. It should always be considered how **existing forest** stands and **local biodiversity** are incorporated. The sustainable management of forests can be ensured through **independent certification**, which takes into account the interests of local people and the preservation of biodiversity.

The use of new technologies such as **satellites and AI** are also important solutions to provide the transparency and reliability of forest ecosystem protection. **Measuring and monitoring** species abundance and diversity are key aspects of sustainable forest management.

5.6.2. Positive Land Use: Regenerative Agriculture – Key Solution for Nature Restoration

As discussed in previous chapters, industrial and extensive agriculture is a major driver and cause of biodiversity loss worldwide. The loss of fertile soils and biodiversity, as well as the loss of indigenous seeds and knowledge, is a mortal threat to future survival.

At the current rate of soil degradation (i.e., decarbonization, erosion, desertification, chemical pollution), serious damage to public health will result from a degraded food supply characterized by reduced nutrient content and loss of key trace elements.

At the same time, current trends indicate that there will literally **not be enough arable land to feed humanity**. Without protecting and regenerating the soil on the world's **4 billion hectares** of arable **land**, 8 billion hectares of pasture and **10 billion hectares of forest**, it will be impossible to feed the world, keep global warming below 2 °C or halt the loss of biodiversity. The solution to these existential global environmental and social challenges can be found in a **regenerative form of agriculture**.

Regenerative Agriculture[138] is a conservation and rehabilitation approach to food and farming systems. It focuses on topsoil regeneration, increasing biodiversity, improving the water cycle, enhancing ecosystem services, supporting bio sequestration, increasing resilience to climate change, and strengthening the health and vitality of farm land.

Key to regenerative agriculture is to go beyond 'not harming' land to **actually improving land** through **soil and environmental regeneration technology**. Regenerative agriculture creates healthy soils capable of producing quality, nutritious food, enhancing rather than destroying land, ultimately leading to productive farms, healthy communities and economies. This **dynamic and holistic approach** to improving food production, farm incomes and, most importantly, topsoil, incorporates permaculture and organic farming practices such as conservation tillage, cover cropping, crop rotation, composting, mobile livestock and grazing. Numerous farming, ranching and land use practices are already being used to create regenerative food systems and healthy natural ecosystems, such as Aquaculture, Agroecology, Agroforestry, Biochar, Compost, Holistic Planned Grazing, No-till, Pasture Cropping, Perennial Crops and Livestock farming landscapes with a low carbon footprint and high animal welfare.

[138] Regenerative International (2024, Agriculture).

One is the world's leading institutions in the field of regenerative transformation is the ***Savory Institute***[139], founded in 2002 by Allan Savory Allan Savory and Daniela Ibarra-Howell. The Institute promotes the large-scale regeneration of the world's grasslands and the livelihoods of their inhabitants through holistic management. Its global network of 24 accredited centres on six continents has officially passed the milestone of 10 million hectares of transformed grasslands and trained nearly 9,000 people.

For investors, the wide range of innovative farming practices and the use of new technologies are new investment opportunities in the transformation of food production. **The focus is on conserving and restoring natural diversity**, sustainably improving food production and social aspects of food security.

However, buying farmland outright can be challenging for large investors, as the often small-scale management, social implications and ongoing monitoring require a high level of expertise, and also carry potential political risks that institutional investors in particular want to avoid.

Alternatively, **investment solutions** are available in the form of **private equity funds** that enable the transformation of agricultural management, control, and measurement of environmental and natural impacts, while offering an attractive risk/return profile.

The following case study illustrates how regenerative agriculture is used in an investment plan and illustrates the different areas of application.

> *Desertification is a fancy word for land that is turning to desert, and this happens only when we create too much bare ground. There's no other cause. I intend to focus on most of the world's land that is turning to desert.*
>
> *Allan Savory*

Regenerate – RESA

The *Regenerate European Agriculture Strategy* leverages and builds upon the agricultural investment fundamentals by applying both an **economic** and a **regenerative** value add plan to each investment, thereby increasing capacity, performance and sustainability. Regenerate seeks to acquire agricultural enterprises with inherent entry value created by underutilized land, attractive entry terms by avoiding price premium and strong prospects for an economic and a regenerative transition.

Many of the opportunities for economic value improvement derive from high operational and financial leverage caused by excessive focus and reliance on EU subsidies, synthetic inputs, and underutilization of land. The focus on the economic improvement or turnaround of farming businesses are threefold:

- Scaling the business through acquisition and greenfield expansion
- Improved financial management and governance, and
- Financial de-leveraging

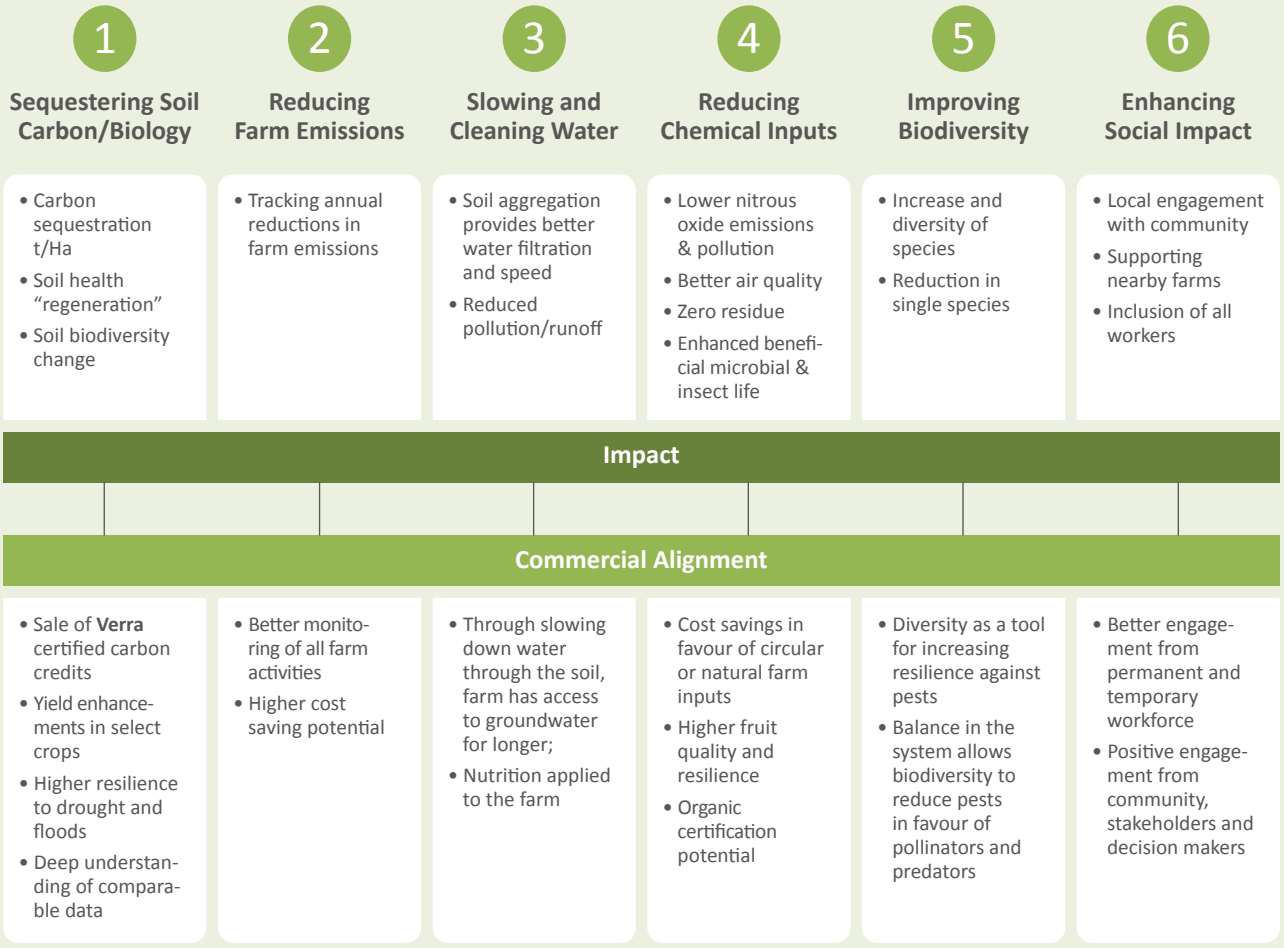
The economic focus is complementary to the ecological and operational turnaround of the business which focuses on regenerative and sustainable land management practices. The ecological and operational value enhancements are interconnected because land use is transitioned or repurposed to make the most efficient use of the farm's assets. Integrating these components adds value in two ways:

- Increasing the **capacity** of a farm business by planting or expanding production of a particular site.
- Enhancing the **performance** of a farm business through implementing regenerative practices, training staff and monitoring the positive externalities.

[139] Savory Institute (2024, Grasslands).

The approach delivers environmental benefits by focusing on soil health, efficient water use and pollution prevention, increased carbon sequestration and improved biodiversity by maintaining pest populations to support the thriving of natural predators and pollinators.

Figure 16: Environmental Impact and Economic Alignment of RESA



Source: Regenerate Asset Management (o.A., Agri. Impact) [140]

5.6.3. A New Asset Class – "Nature Equity"

In the case of **direct investment in nature** (land and woodland), current sources of funding rely mainly on traditional land acquisition, government subsidies, philanthropic contributions or offsets. However, these investments do not create a fiduciary contract between the provider and buyer of natural capital.

Most of these investments do not consider creating, protecting or restoring nature in the long term.

Creating a new type of market infrastructure that enables land managers to accumulate natural capital and businesses to invest in it, the *Land Banking Group* has developed a highly innovative solution. Nature and investment are linked in a dynamic and accountable way through ***a digital natural capital account***.

[140] Regenerate Asset Management (2024, RESA Strategy).

The Landbanking Group

As a very innovative solution, The *Landbanking Group* has developed a new concept, **Nature Equity**. This is a completely new accounting standard that uses high-tech monitoring and measuring tools to account for investments in protecting, restoring or enhancing nature. It combines a **unit of biophysical conservation** or enhancement **with a financial reward** and offers outcome-based rewards. Investors, in turn, receive verifiable evidence of nature management.

The Nature Equity contract creates a **new 'asset class'** that is inextricably linked to a *Natural Capital Account (NCA)*. This account records the stock of biodiversity, carbon, soil or water for a particular piece of land. With an *NCA* as collateral, payments for the conservation or maintenance of nature can be recognized as an intangible asset on the buyer's balance sheet. **Nature Equity Contracts facilitate the exchange of nature-related contracts between farmers and companies on an equitable basis**. Nature equity can be recognized as a constitutional contract for nature-based assets, then nature-based securities, and finally for nature-based currencies. [70]

Nature Equity represents a robust, transparent, and mutually beneficial model for investing in the preservation and enhancement of natural ecosystems, offering tangible benefits to both land stewards and investors. Philosophically, Nature Equity assets represent the net "regenerative" asset after the deduction of all "extractive" liabilities. This qualifies Nature Equity as an equity item in a world of full Natural Capital Accounting and thereby as accounting infrastructure for any country willing to adopt the U*N's System of Environmental-Economic Accounting – Natural Capital Accounting standard*.

The examples above illustrate the breadth of innovative investment opportunities in the agricultural sector.

Not only the use of new technologies, but also the design of new capital market instruments enable a completely new way of generating impact-oriented returns. The **combination of high-tech solutions with holistic management approaches** is very promising. However, investors will need to familiarize themselves with the new ideas and at the same time build up a great deal of knowledge.

5.7. Public Market Investment Offerings (Mutual Funds & Public Equity Investments)

Equity investments are another way of incorporating biodiversity factors into an investment strategy. However, it is important to note that the **impact of the investment on nature** and the environment can only be achieved **indirectly** through the selection of companies and their specific environmental policies.

Although the range of publicly available funds dedicated to this topic is growing rapidly, it is advisable to take a close look at the exact data situation and the implementation of the relevant impact factor within the portfolios.

5.7.1. Biodiversity Labelled Equity Funds

IAs outlined in the second Risk Trends and Vulnerabilities report of the European Securities and Markets Authorities report, biodiversity has been on the forefront of investors' interest and many **new funds were launched** in recent years, mainly at the beginning of 2022.[141]

As more biodiversity-focused equity funds enter the market, regulators are becoming increasingly **concerned about greenwashing** and the underlying biodiversity measurement methodologies of these funds.

This chapter takes a closer look at the **equity funds** currently available, the biodiversity ESG data already available and the current pitfalls of biodiversity rating methodologies. By investing in listed equities or equity funds the impact on biodiversity is achieved by the **entirety of activities of the company** rather than specific projects. It is usually accompanied by engagement strategies of the asset managers of these funds. A recent study of *biodiversity labelled funds*, as well as *biodiversity- related funds* found, that:

- A wide variety of terminology and biodiversity measurement methodologies used in funds is leading to a **lack of comparability** and makes it very hard for investors to really understand the different methodologies and biodiversity topics the funds are targeting.
- As of Q3 2023, the **15 biodiversity labelled funds** analysed by *MSCI ESG Research*, had combined assets under management of roughly USD 1 billion.

[141] European Securities and Markets (2023, Biodiversity).

- In terms of biodiversity-related funds, the combined assets under management amount to approximately USD 59 billion.
- By applying the *MSCI Sustainable Impact Metrics* to the funds analysed, it was found that funds with the term "biodiversity" in their name had, on average, twice the sustainable impact revenue of their peers.

An analysis of the sectors in which the 10 biodiversity-labelled funds with the highest AUM invest in shows insightful information.

What stood out the most were that **cyclical sectors** were dominant, with industrials on average accounting for the largest sector exposure, followed by information technology and materials, with nearly no exposure to the energy sector.

While the absence of energy related stocks in these funds is quite trivial, the relatively high portfolio exposure to sectors like information technologies, financials, and industrials, as well as the high deviation in funds exposure to these industries shows, that **biodiversity measurement** between the funds **differs** and that it is not trivial to determine whether a certain industry or company has a positive or negative effect on biodiversity. Assessing the impact of publicly listed companies and industries on biodiversity is very complex, needs reliable data and demands a clear and comprehensive methodology.

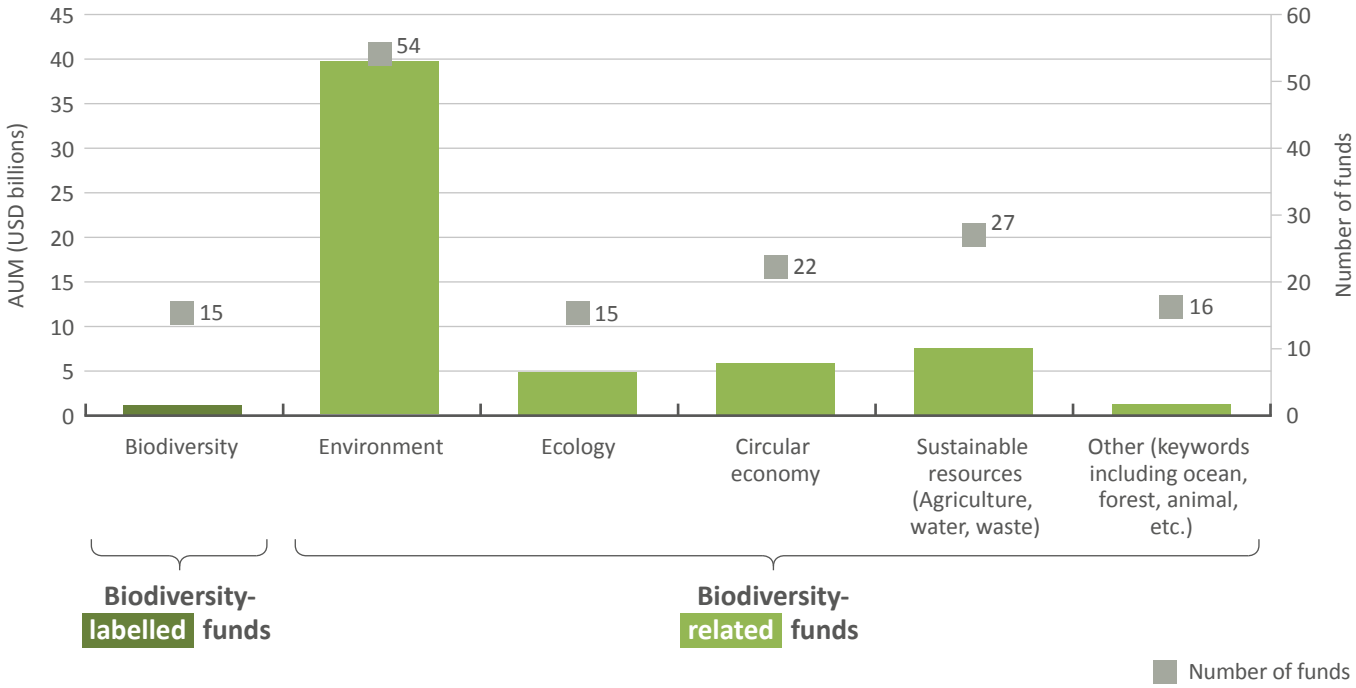
Investment Themes of Biodiversity Focused Funds

Navigating the currently available ESG data and methodologies used for biodiversity assessments in publicly traded funds can be complex and funds should **disclose as much information as possible**, to make it possible for their investors to get an overall understanding of the concepts and data used to have a real impact on biodiversity protection or conservation.

Most of the already existing biodiversity labelled funds can be assigned to one of the following categories:

- **Funds with a focus on ecosystem health** aim at protecting wildlife, non-marine ecosystems, and the general biosphere by investing mostly in companies which are not active in areas with sensitive biodiversity, do not produce unrecyclable waste, focus on overall efficiency, do not pollute the environment, and contribute to the SDGs and climate targets.

Figure 17: Biodiversity-Labelled vs. Biodiversity-Related Funds: A Market Analysis



Source: MSCI (2023, Biodiversity Funds) [142]

[142] MSCI (2023, Biodiversity Funds).

- **Funds with an ocean focus** aim at protecting marine ecosystems and species by investing mostly in companies where a proactive engagement with ocean-related portfolio companies allows for a measurable positive impact, companies' that use ocean resources more efficiently to gain a competitive advantage, or companies concerned with and attentive to CO_2 emissions, end-of-lifecycle product waste, and discharge into bodies of water, as well as companies committed to environmental protection.[143]
- **Funds with a focus on the circular economy** mostly invest in companies which contribute to a sustainable use of natural resources and renewable processes, as well as companies active in the machinery and packaging industry. These companies need to represent an alternative economic model to the default "make-use-throw away" approach of consumption, which is believed to be unsustainable given scarce resources and the rising cost of managing waste.[144]
- **Funds with a focus on water** mostly invest in companies, which aim at solving the global water crisis or improving the sustainable water collection, as well as companies active in the water technology or infrastructure sector.[145]
- **Funds with a focus on sustainable agriculture** mainly invest in companies active in the agricultural and forestry sector, which have a better ESG profile than their competitors and do no or little harm to the environment by applying the most sustainable business practices or production methods. Most of the funds are structured in a way in which they invest in a collection of solutions that seeks to take advantage of the global trends, innovations, and practices being implemented in the agricultural sector.[146]

The major challenge for public equity and fund investment is the current state of biodiversity ESG data.

To gain a better understanding of the data used in these thematic funds, it is necessary to look at some of the most prominent and more traditional ESG factors, and later provide a brief outlook on possible future factors.

One very prominent **ESG factor** on which most of the ESG funds are focused are **carbon emissions**. While increasing CO_2 emissions are in general the main driver of climate change, they also contribute immensely to **ocean acidification**, which causes a **change in seawater chemistry**, which then presents a serious threat to marine life, **ecosystem health** and people whose livelihoods depend on the ocean.[147]

Focusing on carbon emissions is therefore not just a universal topic for ESG related fund, but also lays the **foundation for most biodiversity funds**, especially for funds focused on ecosystem and ocean health.

While the carbon emission calculation methodology has been around for a considerably long time, a lot of the newly emerging biodiversity factors are rather new and seldomly based on direct reports of the companies but rather often the result of estimation models of ESG data providers.

The most prominent biodiversity factors used in publicly traded equity funds are:

- **Emissions:** air pollution and carbon emissions (CO_2 e intensity, Scope 1, 2, 3 emissions)
- **Waste:** waste generation, waste efficiency, non-recycled waste ratio, hazardous waste emissions, disposal methods, pollution prevention and remediation, waste reduction and recycling
- **Water:** water efficiency, water usage, water emissions, water scarcity, water extraction, water pollution, marine ecosystem preservation
- **Land:** land usage, land change, land pollution, deforestation, destruction of biodiversity dense and sensitive areas, natural resource exploitation, agricultural production methods, soil quality, land ecosystem preservation, companies' activities in biodiversity dense or sensitive areas
- **Production methods:** packaging, logistics, buildings, energy saving technologies, use of renewable materials

[143] Newday (2022, Impact ETFs).

[144] BlackRock (2020, Circular Economy Fund).

[145] Pictet Asset Management (2024, Water).

[146] Lazard Asset Management (2024, Agriculture Funds).

[147] Tarakanov (2022, Acidification).

- **Expenditure:** capital and operational expenditure, as well as research and developing spending in connection to biodiversity topics
- **Consumption:** consumption of sustainable produced, sourced and renewable raw materials, no use of exhaustible resources
- **SDG:** Most of the ESG data providers offer some sort of SDG metrics, in which they map mostly companies' business operations and products, as well as certain revenue streams to the *UN SDG*. In biodiversity funds SDG 6 (clean water and sanitation), SDG 12 (responsible consumption and production), SDG 13 (climate action), SDG 14 (life below water) and SDG 15 (life on land) are the most used SDG metrics.

AI and sentiment analysis of company related news:

In recent years AI and data science methods have gained increasing importance in the collection of biodiversity related information published by companies or news agencies. While AI allows to screen millions of company reports and extract biodiversity related information from them, the reliability and context in which the information was disclosed remains one of the biggest pain points of data critics.

AI has also allowed fund managers to screen publicly available newspaper articles about companies in relation to biodiversity related information and analyse the sentiment of these articles, allowing them to get a better understanding of the biodiversity related public perception of the companies they invest in.

While the offered analysis data might look rather comprehensive, the biggest challenges of biodiversity data remain **quality, availability, accessibility, timeliness, and comparability**. One of the main problems with biodiversity data is the quality and coverage of these factors.

- Data directly reported by the company is only available in **very limited quantities** and **estimations by data providers** are the norm, which impacts the quality of these factors. While a limited number of publicly listed companies might indeed have some of these metrics internally available, they rarely disclose it for varying reasons.
- Since **timeliness** is a problem of ESG data perse, the problem is even more pressing in the biodiversity context. Data collection, aggregation, validation, and publishing of these factors is **immensely complex** and requires an enormous amount of competence, time, and funding. Information disclosed by the companies is often already outdated at the time of publishing.
- Another important problem that investors and managers should keep in mind is the **missing comparability of most of these factors**. Most ESG data providers have their own estimation models in place, which are either industry, region or even based on the size of the company and mostly follow completely different underlying methodologies.

Until regulators implement **binding reporting standards**, these estimated factors are the best information available, and investors need to trust the investment strategy, as well as the impact and biodiversity assessment methodology of their fund managers.

This underlines the **need for transparency and disclosure** for both ESG data providers in terms of their methodology and data collection approach, as well as for fund managers in terms of the impact measurement methods they use.

With the ***Global Reporting Initiative*** *(GRI)* launching their biodiversity reporting framework, as well as with the development of disclosure recommendations like the *TNFD*, we see regulation and reporting initiatives catching up and assisting investors and organizations to better understand which decisions and business practices lead to biodiversity loss, where in their value chain impacts occur, and how they can be managed.[148]

- Through **increasing regulation and standardized disclosure** methodologies, the future of biodiversity related ESG factors is looking brightly, allowing fund managers to only select companies that really make an active contribution to biodiversity protection, making equity funds an increasingly important tool for the financing of biodiversity protection. Until the quality biodiversity data has further improved, it is always worth selecting a fund manager with not only a quantitative investment approach, but someone, who performs a **strict biodiversity focused qualitative company due diligence** check and really knows the invested companies.

[148] GRI (2024, Biodiversity).

6 Biodiversity Measurement: Guidance for Investors

Antje Biber

Measuring biodiversity is important both for managing the biodiversity challenge and for investors to make investment decisions to their advantage. This chapter provides guidance to investors by presenting the key **measurement approaches** (6.1), **biodiversity metrics** (6.2) and the **recommendations of the *Taskforce on Nature-related Financial Disclosures (TNFD)*** on reporting and managing nature-related risks (6.3).

While the integration of biodiversity considerations into financial decision-making is gaining importance, it is crucial to recognize and address several challenges associated with the evaluation of biodiversity impact in financial instruments. The data reported by companies and other financial investment opportunities often falls short in providing a comprehensive understanding of their true impact on biodiversity.

There are several challenges with the data that companies report, including:

- **Variability and inconsistency of the data**: While many organizations disclose environmental and social impact data, the specifics related to biodiversity are often incomplete or inadequately detailed. This lack of comprehensive reporting hinders the ability of investors and financial institutions to accurately assess the actual biodiversity implications of their investments.
- **Lack of metrics and standard**: Unlike financial metrics such as return on investment or carbon emissions, there is no singular framework for assessing the impact of economic activities on biodiversity. Different tools and methodologies exist, leading to diverse approaches in measuring and quantifying biodiversity impact. This diversity in standards makes it challenging to compare and benchmark the biodiversity performance of different financial instruments, limiting the effectiveness of cross-industry evaluations.

To address these challenges, there is a growing need for **standardized methodologies and reporting frameworks** that explicitly capture the biodiversity impact of financial instruments. Establishing a common language and set of metrics will not only enhance the quality and comparability of biodiversity data but also enable more accurate assessments of the ecological footprint associated with various investments.

Recognizing the urgency of the situation, industry stakeholders, policymakers, and environmental organizations are actively engaged in **collaborative efforts to develop and promote standardized approaches** for biodiversity impact assessment.

Initiatives such as the *Task Force on* ***Nature-related Financial Disclosures (TNFD)*** are working towards creating a framework that aligns with existing financial disclosure initiatives and focuses specifically on biodiversity-related risks and opportunities. Compared to the measurement and disclosure of climate-related data, standardized by the ***Task Force on Climate-related Disclosures (TCFD)***, the standard for the disclosure of nature-related data is still in its infancy stage.

Increasingly, with the slowly beginning trend towards a more nature considerate economy, companies are starting to set nature or biodiversity goals, promising ambitious things such as **"*Zero Net Loss 2030*"** or **"*Biodiversity Positive*"**. This brings rise to methods of measuring and quantitatively analysing biodiversity as well as human impact on environments.

6.1. Measurement Approaches

Three types of measurement approaches can be differentiated:

1. the **sector screening** approaches,
2. the **location screening** approaches, and
3. **dependency and impacts assessments (biodiversity footprinting)**.

The tools and matrices included within these categories enable valuable biodiversity insights for companies. It must however be kept in mind, that such detailed investigations are yet to become the norm. More widespread data coverage around the world is required to effectively quantify the specific interactions between the economy and our planets biodiversity.[149]

6.1.1. Sector Screening Approaches

Sector screening approaches are designed to assess and manage the impacts of different economic sectors on biodiversity. Considering the unique ecological footprint of different sectors such as agriculture, mining and construction, they provide a systematic way to assess and mitigate sector impact on biodiversity. By integrating sector-specific indicators, guidelines and performance metrics, these approaches enable investors to identify key biodiversity risks and opportunities.

ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure) is a sector screening database which aims to bridge the gap between financial institutions and nature. It highlights how strongly the economy depends on nature and how environmental degradation could impact financial stability. It allows users to identify the dependency of economic sectors on natural capital whilst displaying the material risk, associated with the degradation of the environment. Users can discover the **impacts and dependencies** of over **167 economic sectors on 21 ecosystem services** as well as the corresponding economic loss resulting from a collapse of these individual services.[150]

6.1.2. Location Screening Approaches

Location screening refers to the evaluation of the geographical locations over which an organizations industrial activity may have influence. This influence may be caused by, for example, owning a production plant in the area or through an investment made into an asset. Carrying out a location screening gives insight into the **local environmental circumstances** and what must be considered to operate sustainably and harmoniously with nature.

The ***Integrated Biodiversity Assessment Tool (IBAT)*** is a great example of a location screening tool. The tool was developed by leading conservation institutions such as *BirdLife International*, *Conservation International, International Union for Conservation of Nature (IUCN)* and the *United Nations World Conservation Monitoring Centre (UN-WCMC). IBAT* is a database which offers up-to-date biodiversity data to support informed decisions among leaders within business, government, conservation and other sectors. The tool aims to support sustainable development throughout the world. The datasets are constantly maintained and consist of the *IUCN Red List of Threatened Species*, the World Database on Protected Areas and the World Database of Key Biodiversity Areas. *IBAT* is thus able to provide extremely current, **geolocated data on biodiversity and conservational risks**.[151]

As the global demand for **infrastructure development intensifies**, the potential impact on biodiversity becomes a critical consideration. Balancing the need for economic progress with the conservation of biodiversity requires robust assessment tools.

The following case study illustrates a **real-life example** where *the Integrated Biodiversity Assessment Tool (IBAT)* and the *ENCORE tool* have been used to assess the impact of infrastructure projects on biodiversity. The utilization of these tools demonstrates a **proactive approach by stakeholders to incorporate biodiversity considerations** into infrastructure planning and investment decision-making processes.

The tools that are used for the evaluation of the two infrastructure projects are following different approaches of biodiversity assessment. The results of the *IBAT analysis* show the amount of endangered species (*IUCN Red List*), different categories of protected areas and different categories of key biodiversity areas within a 50km radius of the project boundary. The *ENCORE* methodology follows a different approach. Here the project is evaluated based on the sub-industry and production process following the *Global Industry Classification Standards (GICS*). The results then show **material biodiversity impacts and dependencies of this specific sub-industry and production process**.

[149] Finance for Biodiversity (2024, Biodiversity Measurement Approaches).

[150] ENCORE (2024, Natural Capital).

[151] IBAT Alliance (2024, Assessment Tool).

Analysis using IBAT and ENCORE (by FERI): Battery and Energy Storage System (BESS) Deux Acren, Belgium

Deux Acren is a BESS infrastructure project located in a small town in Belgium. It is composed of 40 *Tesla* Mega-pack Batteries and is the largest BESS project in Europe as of today. The goal behind this project is to offset the volatility of renewable energy sources while also regulating the network frequency. The area which is covered by the project site is 0.86 ha.

Figure 18: Drone Shot of Deux Acren During Building Phase

Source: Tesla (2022, Energy Storage) [152]

The IBAT analysis shows the following results for a radius of 50 km to the outer project site boundaries:

Figure 19: Results of the IBAT Analysis of BESS Deux Acren

IUCN Red List

4	CR
5	EN

Protected Areas

National:	365
Natura2000:	71
Regional Seas:	0
World Heritage:	1
Ramsar:	1
MAB:	0
Emerald Network:	0

Key Biodiversity Areas

Important Bird and Biodiversity Areas	6
Alliance for Zero Extinction Sites	0
Other	0

Source: FERI, 2024

[152] Tesla (2022, Energy Storage).

The *ENCORE* analysis using Electrical Utilities, Infrastructure Holdings as the classification leads to the following material biodiversity dependencies and impacts:

Figure 20: Results of ENCORE Analysis for the GICS Category Electrical Utilities, Infrastructure Holdings

2 Material Dependencies	3 High or Very High Materiality Impacts
Low materiality: • Mass stabilization and erosion control **Very low materiality:** • Bioremediation	**High materiality:** • Soil pollutants • Water pollutants • Water use

Source: FERI, 2024

Nature and Biodiversity Metrics (NMB) is a tool developed by *MSCI*. It was launched in 2023 and contains more than 110 nature and biodiversity data points. Its goal is to aid clients in measuring and reporting biodiversity and nature related risks and opportunities related to the assets they own.

Similarly to *IBAT*, the tool contains specific geolocated data which allows for detailed biodiversity risk screening in specific areas. *NMB* combines *MSCI*'s asset location database with biodiversity data, to measure the exposure of a company's assets to biodiversity sensitive areas. The tool uses four biodiversity related layers to determine if an area is considered "biodiversity sensitive". These include:

- **Healthy Forests** (based on *Forest Landscape Integrity Index*)
- **Intact Biodiversity Areas** (based on *Mean Species Abundance (MSA)* from *Global Biodiversity Model for Policy Support*)
- **Prime Areas for Conservation** (based on *Global Safety Net*)
- **Deforestation Fronts** (based on the *WWF)*.

In addition, it is also able to determine companies that are directly or indirectly involved with driving deforestation either through production or consumption of commodities such as palm oil, soy or timber.

6.1.3. Dependency and Impact Assessments

The tools outlined aim to give financial institutions more detailed insight into how their organization is directly impacting the environment and vice versa; how the organization is dependent on the environment and its services. Such tools are called **biodiversity footprinting tools** and exist in great numbers:

- The ***Biodiversity Footprint Financial Institutions (BFFI)*** tool details the biodiversity impact of the economic activities in which a financial institution is invested in. Originally developed for a financial institution, the *BFFI* method can also be used to determine the biodiversity footprint of other companies. Through a four-step process, the tool calculates the **environmental pressures and the biodiversity impact of investments**. The tool can be used to analyse the impact of a wide range of assets spanning from an investment portfolio to the impacts of a single project.
- The ***Biodiversity Impact Assessment Tool (BIAT)*** assesses drivers of biodiversity loss and models the impact of corporate operations to quantify the potential impact on biodiversity. The tool follows a five-step process which ultimately provides **biodiversity outputs in the shape of the Potentially Disappeared Fraction of species metric (PDF) and *Mean Species Abundance metric.*** Throughout the assessment, ten environmental impact indicators

from IMPACT World+ are taken into consideration, including: climate change, marine acidification, freshwater acidification, terrestrial acidification, freshwater eutrophication, marine eutrophication, freshwater ecotoxicity, water availability, land transformation, and land occupation. Overall, *BIAT* quantifies biodiversity impacts of organizations and allows investors to judge the biodiversity footprint of their own portfolios.

- ***Biodiversity Impact Analytics (BIA-GBS)*** is a tool that measures the biodiversity impact of companies, enabling investors to pinpoint areas within their portfolios that have high biodiversity impact or dependence. It utilizes the Global Biodiversity Score to **translate economic activities into biodiversity pressures and impacts,** integrating climate databases from *Carbon4Finance* for a refined assessment of climate change pressures. The tool is co-owned by *Carbon4Finance* and *CDC Biodiversité*, supported by a scientific review committee. *BIA-BGS* is designed for financial asset portfolios and indices, offering quantitative estimations of companies' impact and dependence on biodiversity. It assesses the potential biodiversity footprint of portfolios, considering the full value chain of underlying companies and covering pressures such as land use, overexploitation, climate change and pollution.
- The ***Corporate Biodiversity Footprint (CBF)*** assesses the annual impact of corporates, financial institutions, real assets, and sovereign entities on global and local biodiversity. It models the **impact based on products or services purchased or sold**, addressing environmental pressures like climate change, land use, air, and water pollution. Using a granular input/output model developed by Iceberg Data Lab, *CBF* calculates resource consumption and emissions along the entire value chain. The methodology, supervised by a scientific committee, combines modeled and reported data to estimate **impacts in *Mean Species Abundance (MSA)* square kilometers**. *CBF* allows financial institutions to understand their biodiversity footprint, supporting investment and financing decisions that consider biodiversity impacts.
- The ***Global Biodiversity Score for Financial Institutions (GBSFI)*** provides a synthetic view of the biodiversity footprint of financial assets, from a single asset to a comprehensive portfolio. Developed by *CDC Biodiversité,* it measures *Mean Species Abundance* based on the *GLOBIO* model's pressure-impact relationships, covering terrestrial and aquatic pressures. *GBSFI* assesses impacts ranging from land use to pollution, offering a detailed **analysis of financial assets' dependencies on biodiversity**. This tool is crucial for financial institutions aiming to align their investment decisions with biodiversity conservation goals, offering a mix of data for a nuanced assessment.
- The ***Global Impact Database (GID)*** is a comprehensive biodiversity impact database that integrates insights from various data sources with geographic and sector granularity. It measures biodiversity impact caused by pressures like climate change, air and water pollution, water use, and land occupation. *GID* utilizes *ReCiPe* and *GLOBIO* for **pressure-impact modeling and attributes impacts based on companies' value chain responsibility**. Offering monetized results for ecosystem services loss, *GID* aids organizations in reporting and acting on biodiversity impacts of their portfolios, covering a wide range of reporting and non-reporting companies and asset classes.

6.2. Biodiversity Metrics

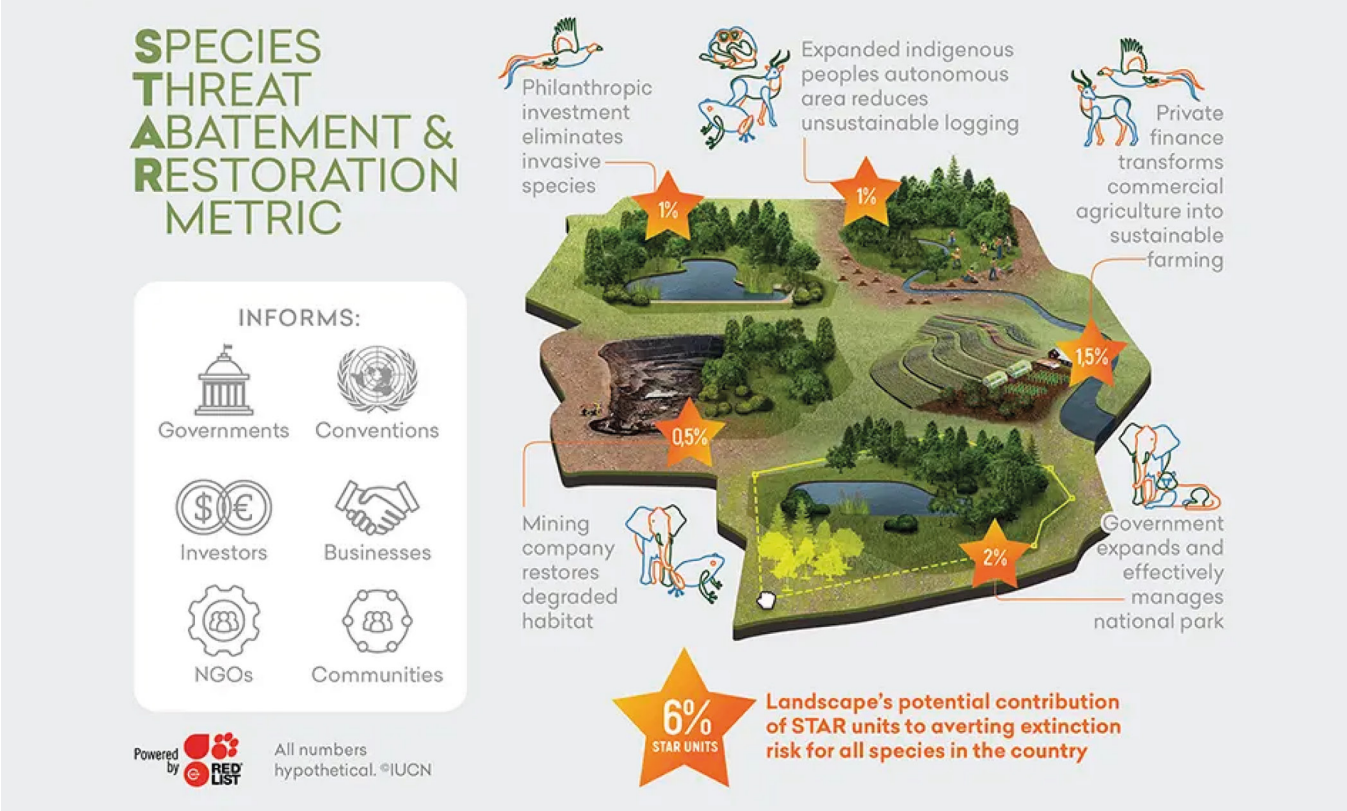
The landscape of biodiversity measurement metrics is broad. Different approaches exist for the evaluation of biodiversity intactness or biodiversity impact assessment. Due to the wide range of different metrics, it is not possible to cover all metrics here. Some biodiversity measurement approaches even use a combination of multiple metrics or variation of metrics for their assessments. The three most important metrics that are in use today are the following:

- ***Mean Species Abundance (MSA)*:** The *MSA* metric has many similarities with the *Living Planet Index* as it also is based on the development (decline) of **species populations**. It is however not very sensitive to monitoring extinction risks. It can be seen as an indicator of naturalness or biodiversity intactness. It is defined as the mean abundance of original species relative to their abundance in undisturbed ecosystems. An *MSA (Mean Species Abundance)* of 0 % means a completely destructed ecosystem, with no original species remaining.

- ***Potentially Disappeared Fraction of Species (PDF):*** The *PDF* has been developed as a footprint metric for the use in life cycle assessments. It indicates the **potential loss of species due to a pressure**, such as land occupation eutrophication, climate change, or other impact drivers. It does not measure final extinction, as the changes in a footprint are generally small compared to globally occurring extinction drivers. Different variations of the PDF are applied in biodiversity impact assessment tools. The most important variant of this is PDF*m^2*yr which refers to the potentially disappeared fraction of species in a dedicated area (in square meters) over a certain period of time (in years). This metric is suitable for the measurement of potential **negative impact on biodiversity in a given area over time**.
- ***Species Threat Abatement and Restoration (STAR)*:** The *STAR* metric measures the contribution that investments can make to **reducing species' extinction risk**. It helps governments, cities, civil society, the finance industry, investors and companies to target their investments and activities to achieve conservation outcomes and contribute to global policy aims. The *STAR* metric bases its scores on data from the *IUCN Red List of Threatened Species.* Further research is underway to extend the application of *STAR* to aquatic environments.

While *STAR* is a scientifically underpinned metric for the measurement of **potential positive biodiversity impact**, it should be noted that its goal is to estimate potential positive biodiversity loss risk reduction. Therefore, it should only be applied for the assessment of projects which aim for positive biodiversity outcomes. The application of the *STAR* metric for the measurement of negative human made impacts on biodiversity is misleading since the metric is positively connotated and cannot express the extent of potential risk but only the potential risk reduction. Nonetheless a high *STAR* metric for a given location means that this area is especially sensitive to negative biodiversity drivers and needs protection.

Figure 21: The STAR Metric



Source: IUCN (o.A., STAR Metric)[153]

[153] IUCN (o.A., STAR Metric).

Besides these metrics which are trying to quantify the biodiversity intactness or potential biodiversity impact there are other methodologies which use a **materiality approach for the estimation** of biodiversity impacts and dependencies of investments.

These methods are more **qualitatively** focusing on the different industries and sub-industries of investments or companies to find the impact on natural capital and dependencies of ecosystem services.

6.3 TNFD Recommendations

The *Taskforce on Nature-related Financial Disclosures (TNFD)* is a global initiative which provides organizations with recommendations to report and act on nature related risks.

It was launched upon increased global recognition of the impact and dependencies of the financial sector on nature and biodiversity. It **aims to increase sustainable investments and focuses specifically on supporting biodiversity and ecosystem services**. The *TNFD* aims to provide organizations with a **global framework** throughout which they are able to disclose their environmental impacts thus allowing for a detailed analysis of risk, dependencies but also opportunities.[154]

The importance of the *TNFD* cannot be overstated, as the promotion of financial transparency in relation to environmental impacts is a crucial step in the redistribution of these resources for the benefit of nature and biodiversity in this area. Although much work is still to be done, the ***TNFD* is at the forefront of global efforts to halt biodiversity loss through biodiversity focused financial reporting**.

The *TNFD* has developed **two frameworks** which are meant to aid financial institutions and other organizations in analysing and reporting the impact the organization has on nature and biodiversity. In addition, the extent to which the organization is dependent on nature and ecosystem services can be measured as well as the associated risks.

The two frameworks are:

- the ***TNFD*** as well as
- the ***LEAP* approach**.

Whilst the recommended disclosures embody the main framework, the **LEAP** approach was developed as a **complementary guide, to display how to identify, assess, manage and disclose** nature-related issues.

As mentioned *TNFD* provides organizations with recommendations of information that should be disclosed to minimize the risk that the organization poses to nature and biodiversity whilst also minimizing the risks that the organization could potentially face. The recommendations made by the *TNFD* are "based on extensive market consultation and pilot testing over a two-year period."

The recommendations are based on **four "disclosure pillars"** which are based on the *Task Force on Climate-related Financial Disclosures (TCFD)* recommendations and are consistent with *ISSB's IFRS Sustainability Disclosure Standards.*

In total there are **14 recommended disclosures** which are all fully aligned with the Global Biodiversity Framework Target 15 requirement which requires disclosure of dependencies, impacts and risks.

These recommendations were developed in cooperation with a wide range of scientific partners and corporate organizations like the *UN Statistics Division*, the *Science Based Targets Network (SBTN)*, the *Global Reporting Initiative (GRI)*, the *International Organization of Standardization (ISO*) and the *Carbon Disclosure Project (CDP).*

As seen in **Figure 22** the recommendations are divided between the four columns governance, strategy, risk & impact management and metrics & targets.

[154] TNFD (2024, Disclosure Pillars).

Figure 22: The TNFD Recommended Disclosures

Governance	Strategy	Risk & impact management	Metrics & targets
Disclose the organisation's governance of nature-related dependencies, impacts, risks and opportunities.	Disclose the effects of nature-related dependencies, impacts, risks and opportunities on the organisation's business model, strategy and financial planning where such information is material.	Describe the processes used by the organisation to identify, assess, prioritise and monitor nature-related dependencies, impacts, risks and opportunities.	Disclose the metrics and targets used to assess and manage material nature-related dependencies, impacts, risks and opportunities.
Recommended disclosures **A.** Describe the board's oversight of nature-related dependencies, impacts, risks and opportunities. **B.** Describe management's role in assessing and managing nature-related dependencies, impacts, risks and opportunities . **C.** Describe the organisation's human rights policies and engagement activities, and oversight by the board and management, with respect to Indigenous Peoples, Local Communities, affected and other stakeholders, in the organisation's assessment of, and response to, nature-related dependencies, impacts, risks and opportunities.	**Recommended disclosures** **A.** Describe the nature-related dependencies, impacts, risks and opportunities the organisation has identified over the short, medium and long term . **B.** Describe the effect nature-related dependencies, impacts, risks and opportunities have had on the organisation's business model, value chain, strategy and financial planning, as well as any transition plans or analysis in place. **C.** Describe the resilience of the organisation's strategy to nature-related risks and opportunities, taking into consideration different scenarios . **D.** Disclose the locations of assets and/or activities in the organisation's direct operations and, where possible, upstream and downstream value chain(s) that meet the criteria for priority locations.	**Recommended disclosures** **A**(i) Describe the organisation's processes for identifying, assessing and prioritising nature-related dependencies, impacts, risks and opportunities in its direct operations. **A**(ii) Describe the organisation's processes for identifying, assessing and prioritising nature-related dependencies, impacts, risks and opportunities in its upstream and downstream value chain(s) . **B.** Describe the organisation's processes for managing nature-related dependencies, impacts, risks and opportunities . **C.** Describe how processes for identifying, assessing, prioritising and monitoring nature-related risks are integrated into and inform the organisation's overall risk management processes.	**Recommended disclosures** **A.** Disclose the metrics used by the organisation to assess and manage material nature-related risks and opportunities in line with its strategy and risk management process . **B.** Disclose the metrics used by the organisation to assess and manage dependencies and impacts on nature . **C.** Describe the targets and goals used by the organisation to manage nature-related dependencies, impacts, risks and opportunities and its performance against these.

Source: TNFD (2024, Adoption) [155]

The previous ***Taskforce on Climate-related Financial Disclosures (TCFD)*** recommendations provide insight into the expected adoption process of the new *TNFD* recommendations: Organizations began adopting *TCFD* regulations by slowly disclosing small sets of *TCFD* recommendations. Over time, the number of organizations disclosing *TCFD* information grew consistently.

As the *TNFD* recommendations are based on the *TCFD* recommendations, it can be assumed that the **acceptance process will be similar**. There is however also reason to believe that *TNFD* recommendations could be adopted quicker. This is because organizations who have adopted *TCFD* recommendations are already familiar to the concept of sustainability reporting and have already set up the necessary internal processes.

An initial market survey indicated that **70 % of respondents** would be able to **start disclosing *TNFD*** recommendations by the year **2025** with the average respondent indicating they would start by disclosing 7 out of 14 *TNFD disclosure recommendations*.

[155] TNFD (2024, Adoption).

TNFD anticipates the recommendations to be **adopted** along three different pathways:

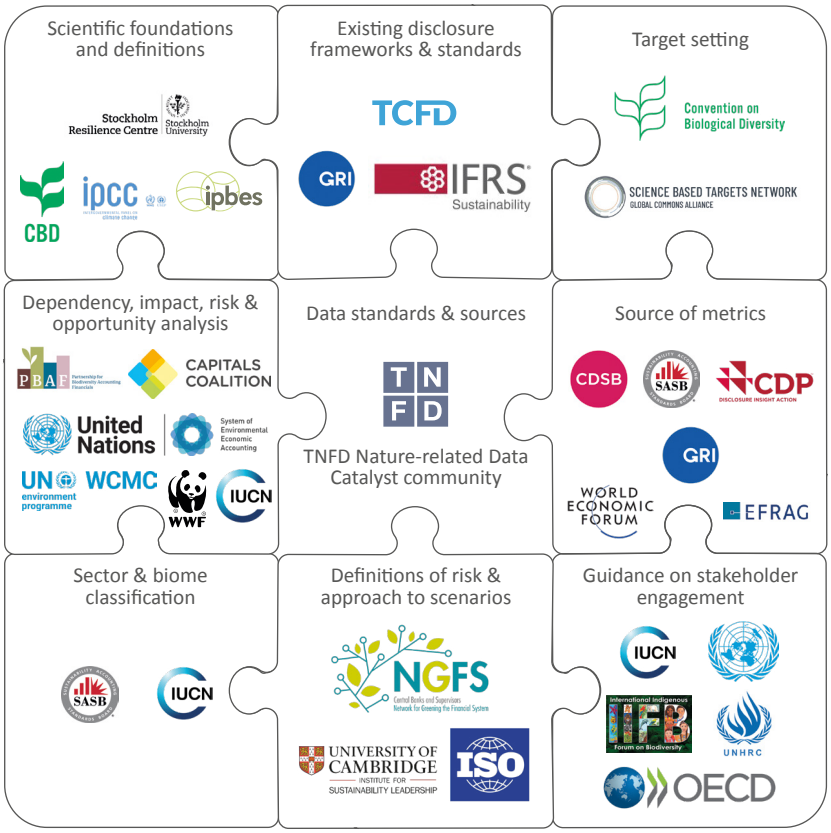
1. Firstly, by guiding the **construction of nature-related disclosure standards** by the *International Sustainability Standards Board (ISSB)*. In December 2022, the *ISSB* signalled its intention to "draw on the work of the *TNFD* as and when it develops nature-related disclosure standards."
2. Secondly, numerous **governments have displayed their support** for *TNFD. TNF*D thus hopes, in collaboration with the *Global Biodiversity Framework (GBF)*, to assist governments in delivering on the GBF Target 15 which calls for corporate reporting of nature related risks.
3. Lastly, as mentioned, *TNFD* hopes that **organizations will voluntarily adopt** their recommendations as a premeasure to potential regulatory changes and to satisfy their corporate social responsibility.

The **LEAP approach** is a corresponding framework which aims to complement the *TNFD*'s recommended disclosures, by demonstrating **how to "identify, assess, manage and disclose nature-related issues**".

LEAP stands for *Locate, Evaluate, Assess* and *Prepare* and is designed for organizations of all sizes, of all sectors and for all locations. The LEAP approach has undergone vigorous testing over a two-year period and has been pilot tested by over 240 institutions.

It was developed in cooperation with a large number of knowledge partners (**Figure 23**) and is consistent with numerous assessment frameworks.

Figure 23: Knowledge Partners Contributing to the Development of the TNFD



Source: TNFD (2024, Recommendations) [156]

[156] TNFD (2023, Recommendations).

TNFD stresses the importance of understanding nature, before making use of the LEAP approach within an organization.

The LEAP approach differentiates between **four different realms**, all of which humans' impact, but nevertheless depend on. These realms consist of **freshwater, land, ocean and atmosphere**.

In addition, all realms but the atmosphere can be classed into **various biomes** which can provide several different environmental assets or services ranging from cultural to regulatory services.

TNFD also identifies five drivers of change within nature. These being:

1. climate change,
2. land/freshwater/ocean use change,
3. resource use/replenishment,
4. pollution/pollution removal and
5. invasive alien species introduction/removal.

TNFD also underlines that investigatory teams should be briefed on the scope of the LEAP investigation, ahead of time.

Basically, it's accurate to say that there are **already extensive, science-based measurements** being made. These measurements can and will be **improved** on an exponential scale **through the use of technologies** such as drones, artificial intelligence and blockchain.

However, this data often relates only to scientific studies, such as specific fields and limited regional areas. Similar data collection by commercial companies, and its impact on nature and biodiversity, is still in its infancy.

International efforts to harmonize and set standards, such as the *TNFD* and the LEAP approach, will lead to a significant increase and improvement in the reporting of economic activities. The need for available and reliable data will also be significantly **increased by regulatory requirements for investors** to monitor and avoid long-term risks, including those caused by environmental damage.

- **Investors can help drive** and catalyse technological developments in **data collection**. Simultaneously, they can increase pressure on companies to provide such data.
- However, all **market participants need standardization** to be able to compare the impacts and interdependencies of economic activities, and thus the impacts of investments.

Types of Biodiversity Databases

Biodiversity databases play a pivotal role in aggregating and organizing vast amounts of biological information, facilitating comprehensive analyses of species distribution, abundance, and genetic diversity. There are different types of databases:

- **Taxonomic databases** focus on organizing information based on taxonomy, providing a systematic arrangement of species.
  - Example: ***Integrated Taxonomic Information System (ITIS)*** is a comprehensive taxonomic database that provides authoritative information on the names and classifications of species.
- **Genomic databases** store genetic information, enabling researchers to study biodiversity at the molecular level.
  - Examples: **GenBank** is a genetic sequence database operated by the *National Center for Biotechnology Information (NCBI)* that includes DNA, RNA, and protein sequences from diverse organisms. **BOLD** focuses on DNA barcoding, providing a repository for DNA barcode sequences and associated metadata for species identification.
- **Ecological databases** capture ecological relationships, species interactions, and environmental conditions.
  - Example: The ***National Ecological Observatory Network (NEON)*** collects and provides long-term, continental-scale data on ecological dynamics, facilitating research on the impacts of climate change and human activities.

Figure 24: LEAP Approach

Source: TNFD (2024, Recommendations) [157]

[157] TNFD (2023, Recommendations).

- **Spatial databases** focus on geospatial information, allowing for the mapping and analysis of biodiversity patterns.
    - Examples: ***BioFresh*** is a spatial database that integrates freshwater biodiversity data, supporting research on freshwater ecosystems and conservation efforts. **Map of Life** combines species distribution data with environmental information, offering a platform for visualizing and analyzing global biodiversity patterns.
- **Citizen science platforms** engage the public in biodiversity data collection, contributing valuable observations.
    - Examples: ***iNaturalist*** is a citizen science platform where individuals can record and share observations of biodiversity, contributing to a global database of species occurrences. ***eBird*** is a birdwatching-centric citizen science platform that compiles bird observation data, providing valuable insights into avian distribution and behaviour.

In addition to the above, the following databases are used to inform policymakers and economic actors:

- ***World Database on Protected Areas (WDPA)*** focuses on cataloging and assessing the effectiveness of protected areas globally. It aids in understanding how economic activities, such as land use changes and resource extraction, impact these critical biodiversity zones.
- ***Global Forest Watch (GFW)*** provides real-time data on deforestation and forest degradation, offering insights into the economic activities contributing to habitat loss and biodiversity decline.
- ***Environmental Performance Index (EPI)*** evaluates the environmental performance of countries, including their impact on biodiversity. It incorporates indicators related to habitat protection, ecosystem services, and species conservation.

7 Conclusion, Future Outlook & Recommendation

Antje Biber, Dr. Tobias Raffel, Prof. Dr. Klement Tockner

- *Biodiversity is both a **significant material risk** and a **new business opportunity** and should be on every investor's agenda today.*
- *There are undoubtedly many challenges to understanding, measuring and managing biodiversity in all its **complexity**.*
- *However, there are a **variety of business solutions and investment opportunities** to be gained by embracing the challenge and playing an active role.*

As the introductory chapter shows, biodiversity and Ecosystem Services (ES) are of **fundamental importance for human well-being and for the creation of economic value**:

- Estimates put the global value of biodiversity at up to **USD 125 trillion per year**.
- However, the increasing loss of biodiversity, mainly due to human activities such as land use change and over-exploitation of natural resources, poses major economic and environmental challenges.
- The degradation of ecosystems affects nature's ability to provide vital services. Advances in technology and science offer new opportunities to understand and address these challenges.

In December 2022, the *Kunming-Montreal Global Biodiversity Framework (GBF)* has provided a **powerful political plan to halt and reverse the loss of biodiversity**, setting forth ambitious goals and 23 action-oriented targets for 2030. The EU, in particular, is currently witnessing a tightening of the regulatory environment, which increasingly requires companies to integrate biodiversity into their financial and economic decisions.

Large companies and financial institutions in the EU must report on their dependencies on nature and risks from the loss of nature for the first time for the 2024 financial year as part of the *Corporate Sustainability Reporting Directive (CSRD).*

There are already **innovative and fascinating strategies for tackling biodiversity** loss.

- **Nature-based Solutions (NbS)** such as reforestation, wetland restoration and green infrastructure **utilize the capabilities and mechanisms of ecosystems**.
- On the other hand, **Technology-based Solutions (TbS)** such as precision agriculture, renewable energy and **advanced monitoring systems** provide an immediate, scalable means of mitigating biodiversity loss.
- Particularly promising are **hybrid solutions that integrate both natural processes and technological innovations** to optimize environmental and economic benefits. It is crucial that the corporate sector takes action now and implements these solutions, for example by applying the "footprint, handprint, heartprint" approach.

Financial institutions and private investors have a crucial role to play in redirecting financial flows away from negative impacts on nature and towards positive outcomes for biodiversity and ecosystems. The growing attention and relevance of the role and impact of the financial sector is reflected in the scale and number of international activities.

Meanwhile, **political and regulatory pressure has been intense** in recent years. Going forward, it will be important to ensure that addressing biodiversity is in the interest of the institutions involved.

The direct **link between accelerating biodiversity loss and changing policy frameworks and financial risks** is already recognized by global central banks. The physical risks arising from the economy's dependence on nature directly affect financial institutions. At the same time, these same financial market participants are exposed to **long-term transition risks due to the negative impact of economic activities on nature**. Considering the impact of economic activities on ecosystems can be both a **source of risk mitigation** and a **source of opportunities**, such as new business, cooperation, and investment opportunities.

However, financial institutions are still far from fully integrating biodiversity loss risks into their processes. Opportunities for direct positive impacts of investments remain unclear and limited.

Incomplete knowledge of interdependencies, unclear and sometimes immeasurable impacts and the basic availability of investment opportunities are undoubtedly the biggest challenges at present.

Nevertheless, there is a very dynamic development in the various segments and asset classes, which opens up interesting and promising investment opportunities:

Monetization and financing of nature restoration and protection

- **Biodiversity credits** can be a future success model for financing environmental protection projects. However, future global standards and reliable verification systems, similar to those for carbon credits, are a prerequisite.
- **Nature conservation bonds** can be used for the protection or restoration of nature in countries where there is a need for financial instruments.
- As the **digitalization of financial investments** progresses, completely new alternative instruments are opening up, the most innovative of which is the **tokenization of nature**.
- In nature restoration, **blended finance** will play a key role. Through risk mitigation mechanisms, the public sector supports private sector investment, particularly in regions considered high risk (emerging markets). This investment structure supports results-based financing options that can link funding to positive increases in ecosystem services with greater transparency of impact.

Labelled bonds – new bond opportunities with positive nature impact

- The rapid growth of the **labelled bond market** (Green Bonds, Impact Bonds, etc.) shows that the financing of climate and nature protection measures by companies and governments is already highly valued by investors.
- Institutional investors are particularly interested because the credit quality of the issuer, the fixed interest rate and the transparent and credible positive impact are in line with their objectives of financing large restoration projects or environmentally friendly corporate activities through bonds.

Private Markets – Innovation and tech solutions in venture capital

- Private markets are increasingly incorporating sustainability factors into investment decisions. **Biodiversity is becoming an integral part of investment strategies**, prompting investors to consider how their portfolios impact the natural world.
- **Regenerative agriculture solutions** have become a key element in the pursuit of eco-friendly and sustainable practices and is offered in Private Equity based investment opportunities.
- **Biotech and food-focused** venture capital funds are providing technology solutions to reduce emissions associated with conventional agricultural processes, from precision farming methods to environmentally friendly packaging solutions. Investment in companies that specialize in (green) carbon sequestration technologies in regenerative agriculture holds great promise.
- Private Equity investments in companies that specialize in (**green or blue) technologies** for **carbon sequestration** in **regenerative agriculture** or in **the marine economy** are showing very promising returns.

Multi-use & Green infrastructure – Economic basis and large-scale opportunity

- **Multiple-use infrastructure** (e.g., combining offshore wind farms with low-trophic aquaculture) projects can be a promising way to improve biodiversity in combination with clean energy. This not only contributes to climate change mitigation, but also has a positive impact on ecosystems.
- Given the rapid expansion of renewable energy generation capacity in response to policy changes, there is reason to be optimistic about channelling even higher levels of investment into nature restoration, taking into account environmental protection measures and multiple-use projects.

"Real assets" – Investing in regenerative agriculture & forestry

- **Forestry investments**, with their attractive risk/return profile and diversification opportunities, have become increasingly popular in recent years, particularly among institutional investors.
- A key aspect of sustainable forest management is the **measurement and monitoring** of species abundance and diversity.
- **The use of new technologies** such as satellites and artificial intelligence are also important solutions for providing transparency and reliability in the protection of forest ecosystems.
- The key to **regenerative agriculture** is to move beyond 'doing no harm' to the land to actually **improving it through soil and environmental regeneration technology**. Regenerative agriculture creates healthy soils capable of producing high quality, nutritious food. It enhances rather than destroys the land, ultimately leading to productive farms, healthy communities, and economies.
- A **wide variety of innovative agricultural practices** and new technology offer new investment opportunities to **transform food production**. The focus is on the conservation and restoration of natural diversity, the sustainable improvement of food production and the social aspects of food security.

Public market investment offerings (Equity and Mutual Funds)

- In the case of investments in listed equities or equity funds, the impact on biodiversity is achieved through the company's overall activities rather than through specific projects. This is typically supported by **engagement strategies** from the asset managers of those funds.
- It can **be complex to navigate through the ESG data and methodologies** that are currently available for the assessment of biodiversity in listed funds. For investors to fully understand the concepts and data used to make a real impact on biodiversity protection or conservation, it is important that listed funds are as **transparent as possible and disclose as much information as possible**.
- While the set of ESG factors may seem quite comprehensive, the biggest challenges for biodiversity data remain **quality, availability, accessibility, timeliness and comparability**. The **quality and coverage** of these factors is one of the main challenges for biodiversity data.

Extensive scientific tools already exist to **measure biodiversity**. The use of technologies such as drones, artificial intelligence and blockchain will exponentially improve these measurements. But this data often only covers scientific research, e.g., on particular subjects and limited regions.

International harmonization and standards efforts will significantly increase and improve the reporting of economic activities, such as the **Taskforce on Nature-related Financial Disclosures (TNFD)** and the **Locate Evaluate Assess Prepare (LEAP)** approach. The need for available and reliable data will also be significantly increased by regulatory requirements for investors to monitor and avoid long-term risks, including those caused by environmental damage.

Investors can be a driver and catalyst for technological developments in data collection. Simultaneously, they can increase pressure on companies to provide these data. In principle, however, **all market participants need reliable and standardized data**. There is still a long and arduous way to go, especially at the level of the investment instruments. It must be possible to better understand and compare the effects and interdependencies of economic activities and thus the effects of investments.

> *Without the financial system, a transformation towards a nature-positive economy cannot succeed. However, this task cannot be accomplished by one institution alone, but requires interaction between private and public actors, i.e. companies, the financial sector and governments.*
>
> Silke Stremlau, Chairwoman, Sustainable Finance Advisory Committee of the Federal Government of Germany

In the coming years, the topic of biodiversity will be included in many investors' analyses, shaping discussions with customers, and leading to a whole range of new and innovative products and services. The rise of climate change to the investor's agenda a couple of years ago can certainly serve as a blueprint here.

Due to increasing regulatory pressure from the European Union, it is **becoming imperative for business and financial sector leaders** to address biodiversity issues now.

The business sector is contributing to the destruction of biodiversity, and decision-makers in companies and the financial sector will be increasingly confronted with questions like:

- How can your negative impact be reduced?
- How can you become part of the solution?
- Which business models work, and which of them are sustainable and competitive?

Every corporate leader should be aware of the urgency of the issue, and **every investor will have to be able to speak competently about biodiversity** sooner rather than later.

In the coming years, the biodiversity debate in business will most likely be dominated by the topics of **regulation, compliance and data**.

Reliable, good data is a prerequisite for understanding and tackling the biodiversity challenge. However, current advances in monitoring technology will soon lead to a significant **improvement in the scope, quality and accessibility of biodiversity data**, and corporate data will complement existing public and scientific datasets.

Many discussions in the coming years will also **focus on practicable solutions** – nature-based, technology-based and hybrid solutions that intelligently combine the two. And for good reasons:

- First, there is a need to **identify the actions** that contribute to solving the problem of global biodiversity loss, i.e., the real (positive) impact of business and the financial sector.
- And second, a **shift in perspective is needed towards a positive view** that sees biodiversity not only as a material risk, but also as a **significant business opportunity** – the 'biodiversity advantage' for the visionary who acts decisively today.

Nature-positive business models and investment strategies, which leverage the synergies between nature and technology, are set to drive this optimistic narrative. Investors, in this emerging paradigm, play a crucial role as catalysts and advocates, exerting influence on businesses to disclose data, innovate solutions, and explore new business models, thereby amplifying and scaling the impact of these solutions.

- ▶ Through **active engagement and leadership**, investors can steer the corporate world towards a sustainable, biodiversity-rich future, where economic and environmental objectives are not only aligned but mutually reinforcing.

List of Abbreviations

ADB	Asian Development Bank
AI	Artificial Intelligence
BFI	Biodiversity Futures Initiative
BNG	Biodiversity Net Gain
CBD	Convention on Biological Diversity
CBI	Climate Bond Initiative
DeFi	Decentralized Finance
EIA	Energy Information Administration
ESMA	European Securities and Markets Authority
ES	Ecosystem Services
FAO	Food and Agriculture Organization
GBF	Global Biodiversity Framework
GEF	Global Environment Facility
GRI	Global Reporting Initiative
IFC	International Finance Corporation
INSPIRE	International Network for Sustainable Financial Policy Insights, Research, and Exchange
IoT	Internet of Things
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
LEAP	Locate Evaluate Assess Prepare
MAPA	Most Affected People and Areas
NbS	Nature-based Solutions
NCA	Natural Capital Account
NCIA	Natural Capital Investment Alliance
NGFS	Network for Greening the Financial System
PV	Photovoltaics
SDG	Sustainable Development Goals
SLBs	Sustainability-linked Bonds
TbS	Technology-based Solutions
TNFD	Taskforce on Nature-related Financial Disclosures
UN	United Nations
UNEP FI	United Nations Environment Program Finance Initiative
UNFCCC	United Nations Framework Convention on Climate Change
UoP	Use of Proceeds
WCB	Wildlife Conservation Bond
WEF	World Economic Forum

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Acknowledgment of the FERI Cognitive Finance Institute:

We would like to thank all our partners and supporters for their cooperation, time and precious input. The content and focus of this study has been significantly influenced by their constructive and inspiring discussions and important support.

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Special thanks go to teams from the FERI SDG Office, the *FERI Cognitive Finance Institute* and the *Senckenberg – Leibniz Institution for Biodiversity and Earth System Research* who all made a very valuable contribution to the success of the study.

With special gratitude for the outstanding support

- Florian Arnold
- Julia Bahlmann

With special gratitude to the contributing authors

- Aidin Niamir
- Carlo Humpert
- Nicklas Kemmner
- Merea Lee
- Björn Traenckner
- Klemens Kressin

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“Without the financial system, a transformation towards a nature-positive economy cannot succeed. However, this task cannot be accomplished by one institution alone, but requires interaction between private and public actors, i.e. companies, the financial sector and governments.”

Silke Stremlau, Chairwoman, Sustainable Finance Advisory Committee of the Federal Government of Germany

Erkenntnisse der Cognitive Finance
ISSN 2567-4927

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