Biodiversity:
A call for decisive action

Under the direction of
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HEC PARIS ALUMNI

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The views, opinions and thoughts expressed in this document reflect only the personal view of the people who participated and not the organisation for which they work. It is a collective work that has been endorsed by HEC Alumni.

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We are very grateful to the following people, and their teams, who kindly shared their experience on the biodiversity topic.

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We also would like to thank the peer reviewers for their time and commitment.

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Abbreviations

IPBES: Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services
UN: United Nations
Ha: hectare
BECCS: Bioenergy with Carbon Capture and Storage
CCS: Carbon Capture and Storage
IPCC: Intergovernmental Panel on Climate Change
GHG: Greenhouse gas

Adrien Couret (H.07)

HEC Alumni President

Take a look out there. Temperatures are rising. The sea nibbles the land and the desert chases living soils away. Natural catastrophies multiply over the years. The blank evidence of global warming and climate change is there, steadily confirmed by the ever more dire reports by scientists from the IPCC.

As public awareness has risen on these crucial matters, other aspects of the environmental crisis, still insufficiently brought to attention, are emerging. Such is the case of biodiversity, that displays stakes and raises challenges at least as significant as climate change on living conditions, business models and human life.

This is why the HEC community, gathering globally 68,000 alumni among which many decision makers, now mobilises to place biodiversity at the top of the transition agenda. This report have the pleasure to introduce is a major contribution to this cause.

To create this report, the authors followed an innovative yet simple approach, which embodies the very fabric of HEC Alumni: a network in which people from many backgrounds meet, share, take action together. That is plainly how this report was born, creating an unprecedented dialogue between acknowledged experts, distinguished decision makers and investors. I am deeply grateful to the numerous contributors to this collective endeavour, and I would like to sincerely thank the core team that coordinated this remarkable achievement in the most passionate spirit.

Without spoiling the in-depth findings of the report, be ready to learn a lot on the fundamental, multi-dimensional frontlines of biodiversity. In the first part, we have strived to bring forth the most accessible and state-of-the-art knowledge on the topic. The second part presents the key learnings from our interviews, as well as eight recommendations to integrate biodiversity into business strategy and practices.

Good reading to all !

Sylvie Lemmet (H.81)

French Ambassador for the Environment

Since COP 21, companies have made very serious progress in assessing the consequences of climate change and developing solutions to decrease their own impacts. Biodiversity loss is another intertwined environmental crisis which shares common roots and deserves equal attention from policymakers, businesses and civil societies considering its multiple consequences for people's livelihoods and the stability of our world systems.

Biodiversity is the base upon which stands our entire world economy. The ecosystem services enable humanity to meet its most basic needs (food, clean water, oxygen) and businesses to produce goods, value and jobs. As a result, more than half of the world economy directly depends on biodiversity.

It is thus key to value properly the services provided by our ecosystems and apply the "do not harm biodiversity" principle to each and every corporate decision.

The Global Biodiversity Framework to be adopted at COP 15 should call on the private sector to mainstream biodiversity into the corporate strategies at every level, from SMEs to multinationals, and align all financial flows in order to achieve net-gains for biodiversity by 2050.

The national governments will subsequently be in charge of its implementation through a whole of society mobilisation. A whole range of policy tools will be required, as the responsibility for the loss of biodiversity is shared across producers, processors, distributors, and consumers. France has already taken a few steps in the right direction by enacting last year Article 29 of the energy and climate law which makes biodiversity impact reporting of investment portfolios compulsory. Besides, the French Presidency of the Council of the EU leads the work on deforestation-free products. Regulation which will strengthen the due diligence of supply chains and reduce the ecological footprint of European producers and consumers. International development programmes also have a decisive role to play in supporting the transition of producer countries.

As far as the private sector is concerned, entire value chains will need to conduct their impact-assessment and dependencies evaluation to test their resilience and identify ways to eliminate their negative externalities on biodiversity. All sectors are concerned, some even more critically than others like agriculture and fisheries, which depend on healthy ecosystems yet take disproportionate responsibility for their degradation. Understanding and reducing the drivers of biodiversity loss is a complex, yet necessary journey. One that I fully trust the business community will embark on, as it has done for climate. Indeed it is not just unavoidable, it is also in the private sector's interest: the first movers are the winners of tomorrow's markets.

I wholeheartedly thank the HEC community for raising awareness on the issue of biodiversity loss among the business community. Building on concrete insights from companies, the report provides useful hints to understand this multidimensional crisis and offers concrete recommendations.

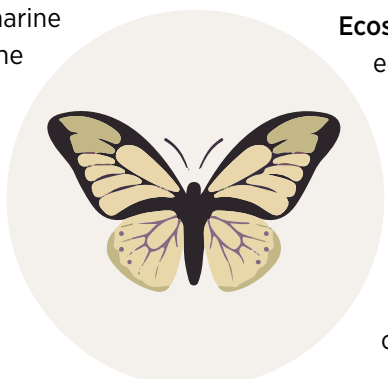
It is a clear example of how we should not be disheartened by the challenges ahead but instead be faithful to the school motto: **"Learn to dare".**

Glossary

Agroecology: The science and practice of applying ecological concepts, principles and knowledge *(i.e.*, the interactions of, and explanations for, the diversity, abundance and activities of organisms) to the study, design and management of sustainable agroecosystems.[1]

Agroecosystem: An ecosystem, dominated by agriculture, containing assets and functions such as biodiversity, ecological succession and food webs. An agroecosystem is not restricted to the immediate site of agricultural activity (*e.g.* the farm), but rather includes the region that is impacted by this activity, usually by changes to the complexity of species assemblages and energy flows, as well as to the net nutrient balance.

Biodiversity: The variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part. This includes variation in genetic, phenotypic, phylogenetic, and functional attributes, as well as changes in abundance and distribution over time and space within and among species, biological communities and ecosystems.[2]



Biodiversity hotspots: An area high in such biodiversity attributes as species richness or endemism. It may be used in assessments as a precise term applied to geographic areas defined according to two criteria: (i) containing at least 1,500 species of the world's 300,000 vascular plant species as endemics, and (ii) being under threat, in having lost 70% of its primary vegetation.

Bioenergy: Energy content in solid, liquid and gaseous products derived from biomass feedstocks and biogas. It includes solid bioenergy, liquid biofuels and same.[3]

Biosphere: The sum of all the ecosystems of the world. It is both the collection of organisms living on the Earth and the space that they occupy on part of Earth's crust (the lithosphere), in the oceans (the hydrosphere) and in the atmosphere.

Carbon sinks: Any process, activity or mechanism that removes carbon dioxide from the atmosphere.[4]

Carbon stocks: Carbon stored.

Ecosystem: A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

Ecosystem functionality: the capacity of an ecosystem to provide benefits to people.

Ecosystem functions: The flow of energy and materials through the biotic and abiotic components of an ecosystem. It includes many processes such as biomass production, trophic transfer through plants and animals, nutrient cycling, water dynamics and heat transfer.

Ecosystem services: The benefits people obtain from ecosystem services. In the Millenium Ecosystem Assessment, ecosystem services are divided into supporting, regulating, provisioning and cultural.

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[1] *IPBES Glossary.*

[2] *IPBES Core Glossary (2022), Retrieved from:https: //ipbes.net/glossary .*

[3] *IEA. (2021), World Energy Outlook 2021, https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf.*

[4] *IPCC. (2014). Annex II: Glossary. In R. K. Pachauri & L. A. Meyer (Eds.), Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (pp. 117–130). In Annex I Glossary in: IPBES (2019), Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages.*

Endemism: The ecological state of a species being unique to a defined geographic location, such as an island, nation, country or other defined zone, or habitat type; organisms that are indigenous to a place are not endemic to it if they are also found elsewhere.

Eutrophication: Nutrient enrichment of an ecosystem, generally resulting in increased primary production and reduced biodiversity. In lakes, eutrophication leads to seasonal algae blooms, reduced water clarity, and, often, periodic fish mortality as a consequence of oxygen depletion. The term is most closely associated with aquatic ecosystems but is sometimes applied more broadly.

Greenhouse gases: Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as halocarbons and other chlorine and brominecontaining substances, dealt with under the Montreal Protocol. Beside CO_2, N_2O and CH_4, the Kyoto Protocol deals with the greenhouse gases sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).[5]

Invasive alien species: Species whose introduction and/or spread by human action outside their natural distribution threatens biological diversity, food security, and human health and well-being. "Alien" refers to a species having been introduced outside its natural distribution ("exotic", "non-native" and "non-indigenous" are synonyms for "alien"). "Invasive" means "tending to expand into and modify ecosystems to which it has been introduced". Thus, a species may be alien without being invasive, or, in the case of a species native to a region, it may develop and become invasive, without actually being an alien species.

Neonicotinoids: Family of insecticidal substances that can notably be used in agriculture - their highly detrimental effect on the environment has led the European Union to ban the use of some substances. In 2021, the French government has exceptionally authorised beetroot seed coating with neonicotinoids to fight against European aphids, transmitting the beet yellowing.[6]

Nutrient cycling: The processes by which elements are extracted from their mineral, aquatic, or atmospheric sources or recycled from their organic forms, converting them to the ionic form in which biotic uptake occurs and ultimately returning them to the atmosphere, water, or soil.[7]

Organic matter: Matter of living organisms, their feces and the matter remaining after decomposition.

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[5] *IPCC. (2014). Annex II: Glossary. In R. K. Pachauri & L. A. Meyer (Eds.), Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (pp. 117–130). In Annex I Glossary in: IPBES (2019), Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages.*

[6] *ANSES, updated in January 2021, Les néonicotinoïdes, retrieved from: https://www.anses.fr/fr/content/les-n%C3%A9onicotino%C3%AFdes (consulted in January-March 2022).*

[7] *Millennium Ecosystem Assessment. (2005). Ecosystems and Human Well-being: Policy Responses, Volume 3. Island Press,Washington, DC.*

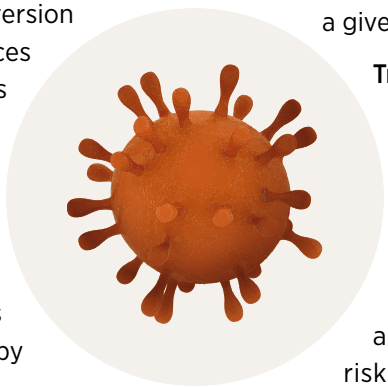
Peatlands: Wetlands that accumulate organic plant matter *in situ* because waterlogging prevents aerobic decomposition, and the much slower rate of the resulting anaerobic decay is exceeded by the rate of accumulation.

Physiological change: A change in the normal functioning of living organisms due to internal factors (age) or external factors (pollution).

Pollination: The transfer of pollen from an anther to a stigma. Pollination may occur within flowers of the same plant, between flowers of the same plant, or between flowers of different plants (or combinations thereof).[8]

Populations of species: All individuals of a species occupying a given location simultaneously.

Primary production: The conversion of energy to organic substances by photosynthetic producers (photoautotrophs), which obtain energy and sunlight, and chemosynthetic producers (chemoautotrophs), which obtain chemical energy through oxidation. Nearly all of the Earth's primary productivity is generated by photoautotrophs.[9]



Public goods: Goods that are not rival in consumption (one individual's consumption does not affect another's opportunity to consume it) and non-excludable (individuals cannot deny each other the opportunity to consume it).[10]

Sedimentary layers: Rock that has formed through the deposition and solidification of sediment, especially sediment transported by water (rivers, lakes, and oceans), ice (glaciers), and wind. Sedimentary rocks are often deposited in layers, and frequently contain fossils.[11]

Species: An interbreeding group of organisms that is reproductively isolated from all other organisms, although there are many partial exceptions to this rule in particular taxa. Operationally, the term species is a generally agreed fundamental taxonomic unit, based on morphological or genetic similarity, that once described and accepted is associated with a unique scientific name.

Species richness: The number of species within a given sample, community, or area.

Transition risks: Risk that materialises through regulatory or market pressure linked to the integration of environmental concerns. Such evolution of the market or regulation can negatively impact companies and lead to stranded assets - representing 'transition risks'. These include abrupt or disorderly introduction of public policies, technological changes, shifts in consumer or investor behaviour and disruptive business model innovation. As such they "relate to [a] process of adjustment"[12] towards a nature-positive economy. For example, anti-deforestation legislation increases due diligence costs for buyers of commodities that could be connected to deforestation.[13]

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[8] *Annex I Glossary in: IPBES (2019).*

[9] *Britannica, updated in January 2022, retrieved from: https://www.britannica.com/science/primary-productivity.*

[10] *Stancheva, S., (2017), Lecture 8: Public Goods, (lecture slides), https://scholar.harvard.edu/files/stantcheva/files/lecture8.pdf*

[11] *https://www.dictionary.com/browse/sedimentary-rock.*

[12] *Network for Greening the Financial System. (2020), Overview of Environmental Risk Analysis by Financial Institutions, https://www.ngfs.net/sites/default/files/medias/documents/overview_of_environmental_risk_analysis_by_financial_institutions.pdf.*

[13] *University of Cambridge Institute for Sustainability Leadership (CISL, 2021). Handbook for nature-related financial risks: key concepts and a framework for identification.*

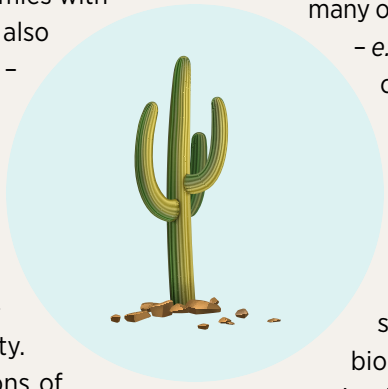
Executive summary

OUR PURPOSE

This report serves two different yet intertwined objectives: (i) raising awareness of the biodiversity crisis in the business community, (ii) delivering a call to business leaders and policymakers to address this crisis with decisiveness and efficiency.

This report is by no means exhaustive or intended to replace the growing scientific literature on the biodiversity collapse, how it is accelerated by our common business models and behaviours, and how businesses are exposed to biodiversity-related risks.

Our objective is instead to contribute to the debate, including by shedding light on current gaps in terms of knowledge, regulation and best practices that we need to bridge to align our economies with a sustainable state of the world, and also to foster dialogue among stakeholders – *e.g.* business executives, policymakers, academics and civil society.



In order to achieve this, we conducted more than 40 interviews with c. 50 biodiversity experts, scientists, NGOs, business leaders and investors – notably from the HEC Alumni community. These interviews form the foundations of the content of this report in terms of learnings and recommendations. We are cognizant that our interviewees only represent a part of the community of professionals involved in the topic. Nevertheless, we are convinced that the value of our contribution notably lies in the in-depths discussions we have been fortunate to have with such a impressive and diverse experts and decision-makers.

THE SCIENTIFIC EVIDENCE BEHIND THE COLLAPSE OF BIODIVERSITY

The first part of the report presents the issue at stake, based notably on the significant amount of scientific literature on biodiversity. We begin by reviewing the precise meaning of biodiversity and overarching concepts, stressing the importance of biodiversity for both our societies and economies.

In people's minds, biodiversity is often primarily seen through the lens of the survival of iconic species. Biodiversity is a broader concept, covering diversity within species, across species and among ecosystems. It is the foundation of our everyday lives. The collapse of biodiversity in particular entails the loss of ecosystem goods and services, many of which are not realistically replaceable – *e.g.* crop pollination, oxygen production, climate regulation.

There is strong scientific evidence that we are experiencing the sixth mass extinction – evidence that is growing by the day due to deteriorating indicators and improvement of scientific knowledge. The loss of biodiversity is observed through species extinctions, population declines, ecosystem loss and deteriorating functional interactions.

This crisis is fueled by five drivers of biodiversity loss: land and sea use change, overexploitation of resources, climate change, pollution, and invasive alien species. Most economic sectors are either exposed to these drivers (dependencies), contribute to them (impacts), or both. The specific features of these interactions call for a sector and value-chain approach to biodiversity.

Mitigating climate change to the level of the Paris Agreement limit is a necessary condition to halt and reverse biodiversity loss. Conversely, preserving biodiversity is a necessary condition to mitigate

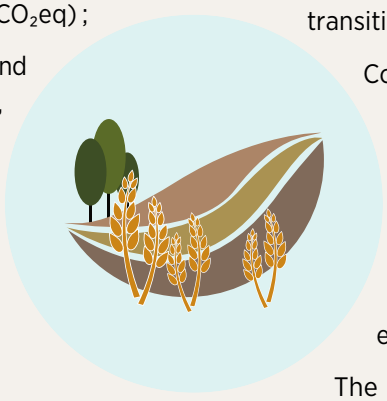
climate change to the level of the Paris Agreement. Climate change and biodiversity collapse mutually reinforce each other. This feedback loop appears clearly when looking at natural carbon sinks which biodiversity provides. Biodiversity is also home to opportunities, both to limit emissions through nature-based solutions, and to adapt societies to face the consequences of climate change. In other words, climate and biodiversity are "twin crises".

We believe that a key to understanding the links between business activities and biodiversity is to adopt a value chain approach, to be able to map dependencies, and impacts on, biodiversity. The main takeaway is that these links work both ways: most industries have a detrimental impact on biodiversity, while relying on goods and services provided by the very same biodiversity.

While highly intertwined with climate change, biodiversity is also different in a few respects:

- It is multidimensional. For instance, the disappearance of species is key, but so are the drop of population within species, the development of invasive species, and the changes to ecosystems;
- It is consequently more challenging to capture through a single metric, which would be the equivalent of the CO_2 equivalent (CO_2eq) ;
- It is also more local, as the impacts and dependencies are often localised, and ecosystems vary widely from one region to the next.

These features have an impact on the approach that businesses, consumers and policy-makers can take towards biodiversity.



BEYOND THE FACTS: TAKING ACTION TO AVERT THE COLLAPSE OF BIODIVERSITY

The second part of the report builds on discussions with business executives, investors, NGOs and biodiversity experts to lay out key recommendations.

The first key takeaway is the importance of building awareness and dialogue among stakeholders, in order to break silos. Awareness of the biodiversity crisis is rising, yet lags far behind that related to climate change. The business community stands well-placed to contribute to the solution, as it can leverage its agility, access to funding, and close understanding of production processes.

However, addressing the collapse of biodiversity will not come without deep ethical and societal debates in order for change to be welcome and effective. It questions the foundations of our economies and notably the belief that resources are unlimited.

Therefore, it is of primary importance that education and training cover environmental issues, including biodiversity. These topics should be included in curriculums. Notably, higher education should both (i) ensure that all students are equipped to understand the key concepts and challenges, and (ii) train highly specialised experts to design the technical and policy changes required for the transition.

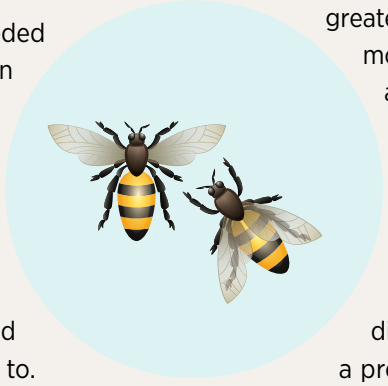
Considering the sheer magnitude of the biodiversity crisis, additional focus should be placed on training current business executives – most of whom graduated when less was known about the collapse of biodiversity – as their decisions could impact the evolution of the crisis for years to come.

The rise in awareness, paving the way for a comprehensive action agenda, will come through several factors which stood out in our discussions. First, a deeper dialogue with the scientific community is required, encompassing both hard and social sciences to adopt a holistic view of the necessary societal changes.

Second, the question of assessment and monitoring will be key to navigate the changing landscape. Carbon emissions have become a convenient aggregated indicator when it comes to climate change. When it comes to biodiversity, there is growing consensus that a unique indicator, while useful, will not suffice, in light of the variety of underlying challenges – pollution, water, sanitation, animal and plant populations, geographic variability.

However, the lack of a perfect indicator should by no means deter action on biodiversity. There is already more than enough scientific evidence, as well as a significant understanding of the key impacts, to trigger decisive action.

Strong corporate governance is needed to ensure the smooth implementation of the major required changes across companies and industries. While regulatory changes might be needed down the road, it seems that there is already ample room for boards and executive teams to ensure companies tackle their impacts on biodiversity and the risks that they are most exposed to.



Finally, innovation can help break new grounds in areas such as nature-based solutions, plant-based proteins, or the circular economy. Technological changes are an important source of hope, yet there is consensus that they are not a silver bullet and will not avert the need for societal changes.

BIODIVERSITY IS INHERENTLY COMPLEX: THE NEED FOR A SECTORAL ANALYSIS

Biodiversity issues are by nature local and specific to each economic sector. This report focuses on a few sectors that will be key if we are to achieve the transition, notably agriculture, and the financial sector.

Agriculture and food production are a cornerstone of the transition, which is set to require a deep rethinking of systems that have been developed over the past centuries, These production models aimed to reduce uncertainty, and ensure the availability of food at affordable prices. This strategy has helped lift millions out of poverty, yet it shows its limits by accelerating the collapse of biodiversity and increasing vulnerability to shocks.

On the production side, there are some painless actions such as tackling food waste is a must and can yield significant benefits. Other changes will involve significantly reducing pesticides and synthetic fertilisers, and reinstating diversity within our agricultural models and diets. More broadly, it means enriching ecosystems and value chains which have previously been gradually simplified to allow for large, standardised production. On the consumption side, establishing incentives and greater product offering to shift diets towards more plant-based and less animal protein is a keystone of the transition, which could also yield significant health benefits.

The construction and energy sectors have an impact mainly through the climate change and land use change drivers of biodiversity loss. While our discussions in those fields were more of a preliminary nature, some first takeaways already emerge, such as the importance of measurements at the facility level due to the geographical diversity of infrastructures.

The construction and energy sectors also illustrate the presence, in some instances, of the need to balance biodiversity and climate change considerations, as illustrated by the fast development of renewables, which can have an impact on ecosystems.

Financial services play a key role in this transition, through the allocation of capital across the economy. The exposure to risks and precise role varies among the types of sub-sectors, which are analysed in more depth in the report. Nevertheless, there was consensus in our discussions on common fundamental objectives - the need to play an active role in the transition - and challenges currently faced by the sector, including the need to improve the availability and quality of data to take the most efficient actions. The specific features of biodiversity

risk - such as the absence of precedents of this magnitude - lead to the need to create new models and anticipate the crisis as much as possible.

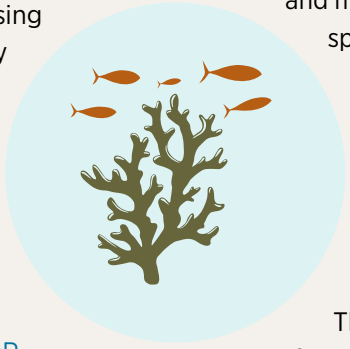
BUILDING MOMENTUM

The last question tackled by the report is that of building momentum to ensure the necessary actions are taken in time before disaster hits.

First, it is important to underline the role of consumers in changing their habits in order to encourage the transition of large industries such as the agri-food sector. Awareness of the biodiversity crisis has been growing among the civil society, and changes in consumption patterns are levers in the short-term to accelerate the transition. Support mechanisms must be developed for the underprivileged to enable a society-wide and just transition.

Second, the role of policymakers will be key to tackle externalities that would not be taken care of based solely on economic incentives. Biodiversity is set to – or should, at least – become an important part of all policy decisions, from budgeting to public procurement and taxation. An increasing alignment of subsidies with biodiversity objectives is critical to support the companies in its transition.

Lastly, the response to the biodiversity crisis requires a timely and coordinated manner across countries, supported by an important multilateral dialogue.



THE BIODIVERSITY CRISIS: A CALL FOR INTEGRATED AND GLOBAL ACTION

The loss of biodiversity is a major, systemic threat to our societies which must be urgently dealt with. Reversing this trend will require a profound transformation of our societies and economies which can only be achieved through widespread action from all stakeholders: public and private. These actions will only be efficient if they are designed following an integrated, global approach to biodiversity loss spanning entire value chains, crossing sectoral boundaries and public/private divides.

KEY TAKEAWAYS FOR BUSINESS LEADERS

While biodiversity will require the crafting of local and sectoral solutions, some transversal takeaways stand out for all business leaders. In order to avert the biodiversity collapse, they will need to ensure that:

- They are up to date with the main concepts related to biodiversity, and the drivers of the biodiversity crisis;
- They have adequate knowledge of the biodiversity risks that their company is exposed to, and the extent to which their business model relies on biodiversity;
- Their corporate governance is designed to take into account biodiversity issues both in day-to-day business decisions and in longer-term strategic planning;
- Employees have access to training on biodiversity issues, both the general concepts and more idiosyncratic issues related to their specific line of work.

Finally, business leaders can benefit greatly in this endeavour from an in-depth and constructive dialogue with outside stakeholders including policymakers, scientists and civil-society organisations.

This report aims at laying ground for several of these different steps, with actionable insights and best practices. Many of the actions listed above are well within reach and can be launched in the very short-term, engaging company-wide dialogues to build momentum to address the biodiversity crisis.

METHODOLOGICAL APPROACH

In this work, we aimed at discussing with a diverse set of stakeholders (business and finance, NGOs and experts) about the issue of biodiversity erosion. We sought to explore the stakes related to biodiversity for the private sector, the level of awareness on the issue, the approaches and solutions implemented and the potential challenges identified. The final goal of this work is to contribute to awareness among the private sector, public authorities and civil society about the importance of biodiversity, and the urgent need to take action.

- In the first part of the report, we offer a brief summary of existing knowledge to present what is biodiversity, why it matters to protect it, what threatens it, and the links between businesses and biodiversity. Furthermore, we have tried to present the key concepts that allow to un-silo climate and biodiversity issues, which are sometimes called "twin crises" in scientific literature. While we do not claim to be comprehensive, this part is based on a broad review of scientific and grey literature (see appendix).

- In the second part of the report, we draw from over 40 interviews conducted with c. 50 professionals from all relevant fields (private sector, scientific and research institutions, NGOs, etc.), and propose takeaways to business and policy makers. This part, and the takeaways presented, are not a direct reformulation or retranscription of the content of the interviews. It is based on our analyses, perspectives and thoughts on these interviews, also fueled by complementary readings. Consequently, the recommendations in this section were not necessarily made by our interviewees, although several were discussed in certain interviews.

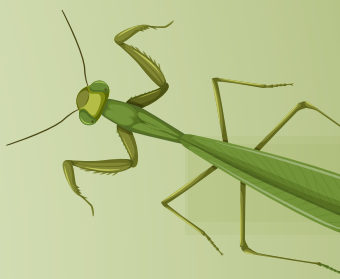
- One of the strengths of this report is the diversity of professionals who were interviewed (companies from different industries, NGOs, members of the finance community, researchers across different disciplines). Constrained by time and resources, we have focused for now on a few economic sectors, mainly agri-food and finance, and on global actors of the French economic ecosystem, which appears as one of the most advanced geographic markets on the topic of biodiversity.

- We are of course not fully exhaustive nor representative in terms of company sizes, sectors or geographies, or in terms of the diversity of actors involved in the ecological transition. Rather we aim at giving a view of the relations between business and biodiversity - which does not cover all subjects linked to biodiversity.

- Finally, our report is not scientific, in the sense that we do not produce new scientific evidence of knowledge, but rather synthesise information, and aim at raising awareness about biodiversity erosion while drawing some recommendations.

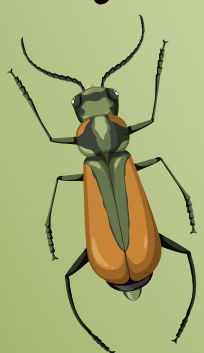
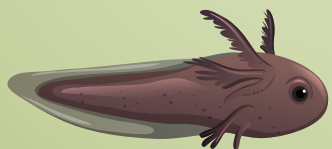
PART I

A. Biodiversity and overarching concepts





For the fourth time since 2011, the "loss of biodiversity" appears in the top 5 most severe global risks over the next ten years in the World Economic Forum's Global Risks Perception Survey.[14] Among them, the risk of new zoonotic disease is clearly identified. After the Earth Summit (1992), the Nagoya and Aichi targets, the Metz Charter for biodiversity (2019), the IUCN Congress (2020) and COP15 in 2021, when will the world take action?

1. BIODIVERSITY IS THE RICHNESS OF LIFE ON EARTH

Up to now, biodiversity was embedded in people's minds through a few iconic species, namely pandas, bees or rhinoceros. But it is much broader: is refers to all life on Earth.

Biological diversity or biodiversity, refers to all living organisms, their interactions and functionalities (their respective roles) of the living world. The Convention on Biological Diversity (CBD), the international convention designed to halt biodiversity loss, defines biodiversity as "the variability among living organisms[15]", including three types of diversity (see Figure 1):

- **Diversity within species**

  Example: the genetic material of each individual is unique.

- **Diversity between species**

  Example: more than 20,000 different bee species have been identified throughout the world.

- **Diversity of ecosystems**

  Example: mountains, glaciers, oceans or coasts are habitats that welcome specific ecosystems adapted to their living conditions. Ecosystems can vary in scales (from the human body to an entire biome); ecosystem biodiversity requires envisioning the interpendencies between species in a multidimensional perspective.

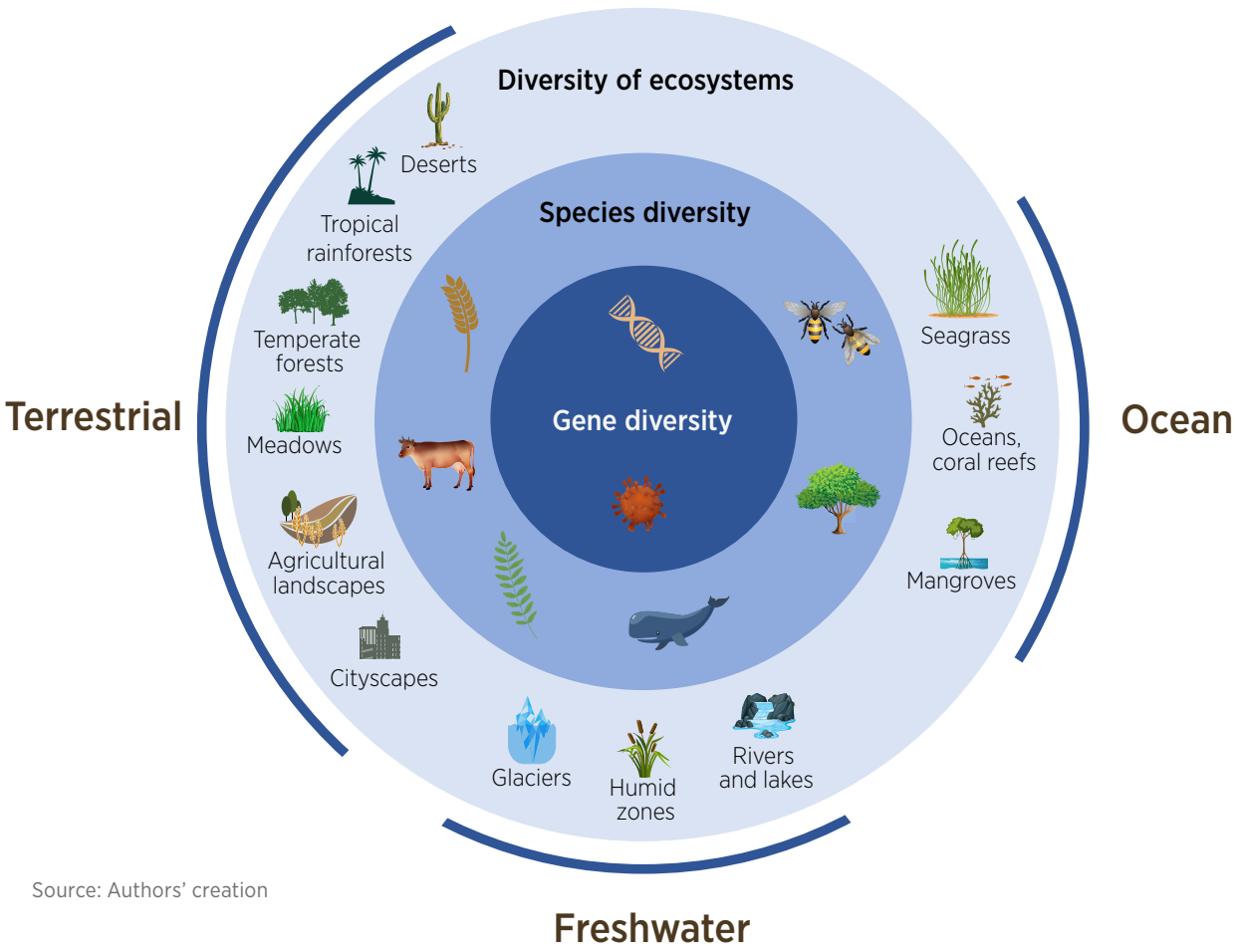
All in all, biodiversity can be summarised as the richness of life on Earth, and the interactions between all living components on the planet. It is supposed to guarantee the evolutionary potential of species.

In this document, we will provide a systemic view of the role that nature plays in our economy. It implies looking at all scales, from high-level (ecosystems) to field-level (species, genes), and reconciling global natural phenomena and business supply chains with local issues (*e.g.* water scarcity).

[14] *World Economic Forum, The Global Risks Report 2022 - Insight Report (Zurich, 2022).*

[15] *Variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" Convention on Biological Diversity (1992). art. 2.*

Figure 1. The three scales of biodiversity



Source: Authors' creation

"From 1997 to 2011, the world has lost between USD4.3 to 20.2 trillion annually in ecosystem services, due to land-cover and land-use changes such as deforestation, conversion of wetlands and other natural areas."

Source: Costanza *et al.* (2014)

2. BIODIVERSITY IS A VITAL MAINSTAY OF OUR SOCIETY AND ECONOMY

Nature provides goods and services that are the foundations of our lives and economies. The diverse ecosystems forming the biosphere[16], when healthy, provide many benefits/services, which we humans, as well as other living species, heavily rely on for our survival and our well-being.[17, 18]

These benefits and services can be divided into 4 categories:

- **Provisioning services:** Nature provides food, wood, fresh water, biochemical and genetic resources (crucial for instance in medicine), energy resources, and other raw materials, as the result of the interaction of living organisms in their ecosystems.

  Essential to: Agriculture, energy, raw materials, textile, etc.

- **Regulating services:** Plants, insects, bacteria and other living organisms improve the quality of the environment they live in by capturing carbon and regulating climate, cleaning the air, filtering water and pollutants, decomposing and treating waste, regulating diseases, ensuring pollination, offering protection against extreme weather events such as floods, or preventing erosion.

  Essential to: Health, water provision agriculture,climate change mitigation, etc.

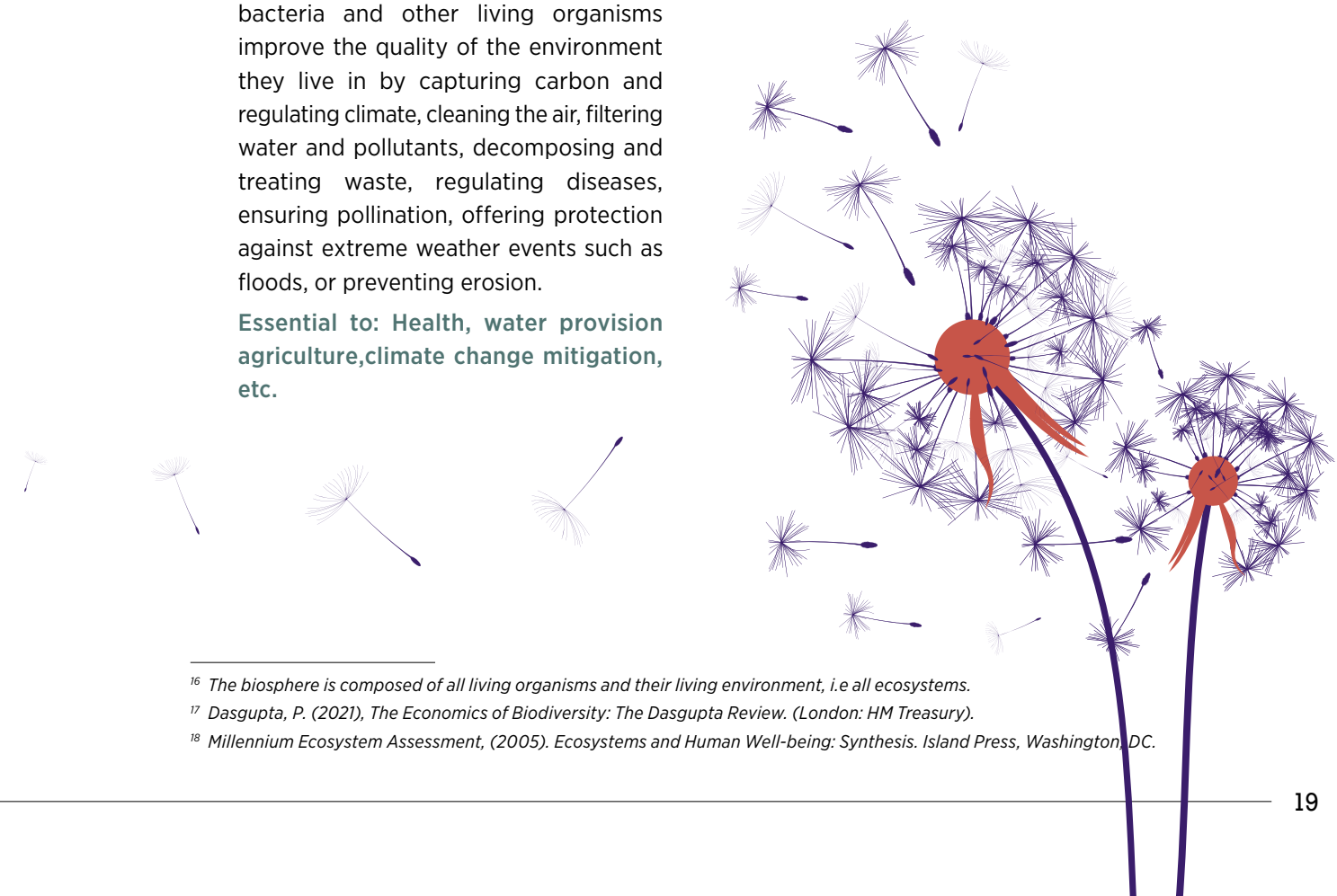
- **Cultural services:** Nature provides recreational and spiritual benefits, and plays a role in our culture, arts, and civilisation as a whole. The natural parks or coastline we visit for pleasure are an example of such services.

  Essential to: Sport and Tourism sector, etc.

- **Supporting services** form the foundations for other ecosystem services and allow ecosystems to keep providing services: nutrient cycles, photosynthesis and oxygen production, primary production (organic matter), water cycle and soil formation, habitat provision.

  Essential to: Agriculture, climate change mitigation, etc.

Without these ecosystem services, life as we know it would not be possible.

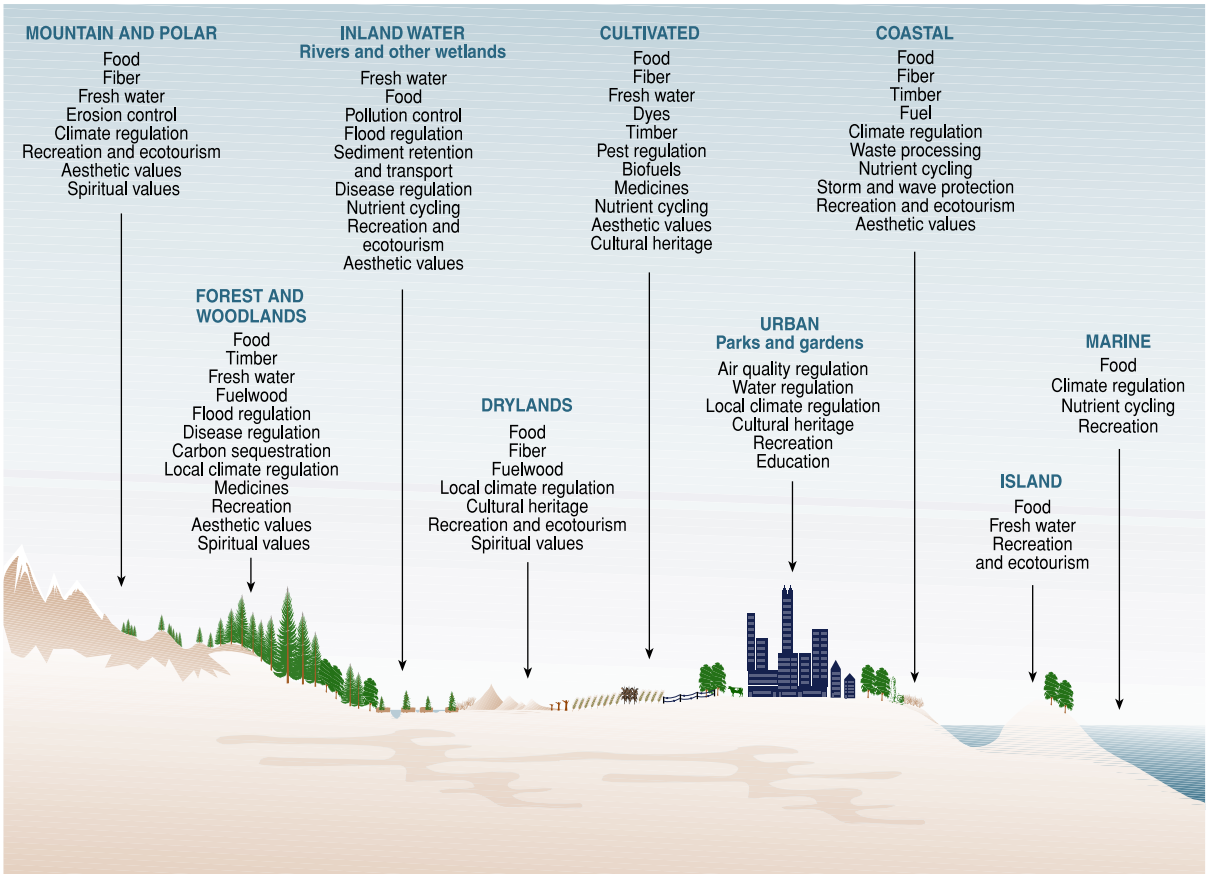


[16] *The biosphere is composed of all living organisms and their living environment, i.e all ecosystems.*

[17] *Dasgupta, P. (2021), The Economics of Biodiversity: The Dasgupta Review. (London: HM Treasury).*

[18] *Millennium Ecosystem Assessment, (2005). Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.*

Figure 2. Ecosystems the services they provide



Source: Millennium Ecosystem Assessment. (2005). Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.

Biodiversity and ecosystem services underpin the functioning, development and well-being of our societies. Humans across the world depend on natural resources and services to meet their basic needs: the 2019 report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) states that 35 out of 44 targets of the UN Sustainable Development Goals related to poverty, hunger, health, water, cities, climate, oceans and land are endangered by biodiversity loss.[19]

For instance, biodiversity is a major reservoir of current and future medicinal treatments. "Natural or naturally derived compounds account for around 75% of approved antimicrobial drugs."[20] Out of 270 000 known plants, 10 000 are used medicinally, such as *Arnica montana*, widely used as a painkiller. "Penicillin used to control bacterial infections and which revolutionised

[19] *IPBES (2019), Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages.*

[20] *IPBES (2020) Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services. Daszak, P., Amuasi, J., das Neves, C. G., Hayman, D., Kuiken, T., Roche, B., Zambrana-Torrelio, C., Buss, P., Dundarova, H., Feferholtz, Y., Földvári, G., Igbinosa, E., Junglen, S., Liu, Q., Suzan, G., Uhart, M., Wannous, C., Woolaston, K., Mosig Reidl, P., O'Brien, K., Pascual, U., Stoett, P., Li, H., Ngo, H. T., IPBES secretariat, Bonn, Germany, (p33).*

Box 1

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

Created in 2012 by 92 governments, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), is an independent intergovernmental organisation responsible for advancing science and informing policymakers on biodiversity and ecosystem services. It is the equivalent for biodiversity of the Intergovernmental Panel on Climate Change (IPCC) for climate change. It notably includes Brazil, France, Germany, the United Kingdom, the United States, etc.

In 2019, IPBES released its "Global Assessment Report on Biodiversity and Ecosystem Services" in which it assessed the changes in global biodiversity over the past 50 years. This landmark report documents in a very detailed manner the magnitude of biodiversity loss and its potential impacts on human societies.

medicine"[21] is derived from several types of fungi (microbial mushrooms). The polymerase chain reaction (PCR) currently used to test daily millions of people for the Covid-19, depends on *Thermus aquaticus*, a thermophilic bacterial organism. The decline in biodiversity is therefore reducing the "future opportunity" of finding essential medicinal treatments.[22]

Hence loss of biodiversity is not only an environmental issue, but it ties into development and economics, security, health and well-being, and deeply challenges our relation to nature and other living species. It also questions justice as populations in developing countries rely more on natural resources and services to answer their basic needs and for their livelihoods, and thus tend to be more affected by the attrition of biodiversity, as opposed to those living in more industrialised countries.

Human existence on Earth depends on biodiversity and yet, evidence shows that many ecosystem services are declining due to human activity. The Millenium Ecosystem Assessment report, published in 2005,[23] states that 15 out of the 24 ecosystem services evaluated are being used in an unsustainable or degrading fashion, including services related to climate regulation, air and water provision and purification, and the provision of fisheries. More recently, the IPBES conducted a similar assessment and concluded that 14 out of 18 categories of ecosystem services have declined since 1970.[24] These ecosystem services are declining either because we use them at a higher rate than their natural renewal rate, or simply because we disrupt the ecosystems that provide them. For instance, humans have over-exploited provisioning services (*e.g.* intensive agricultural production, unsustainable timber harvests and extension of mining extraction) while the supply of regulating and supporting services has declined (*e.g.* decrease in soil organic carbon and pollinator diversity, loss of coastal habitats ensuring protection from floods and other extreme weather events).

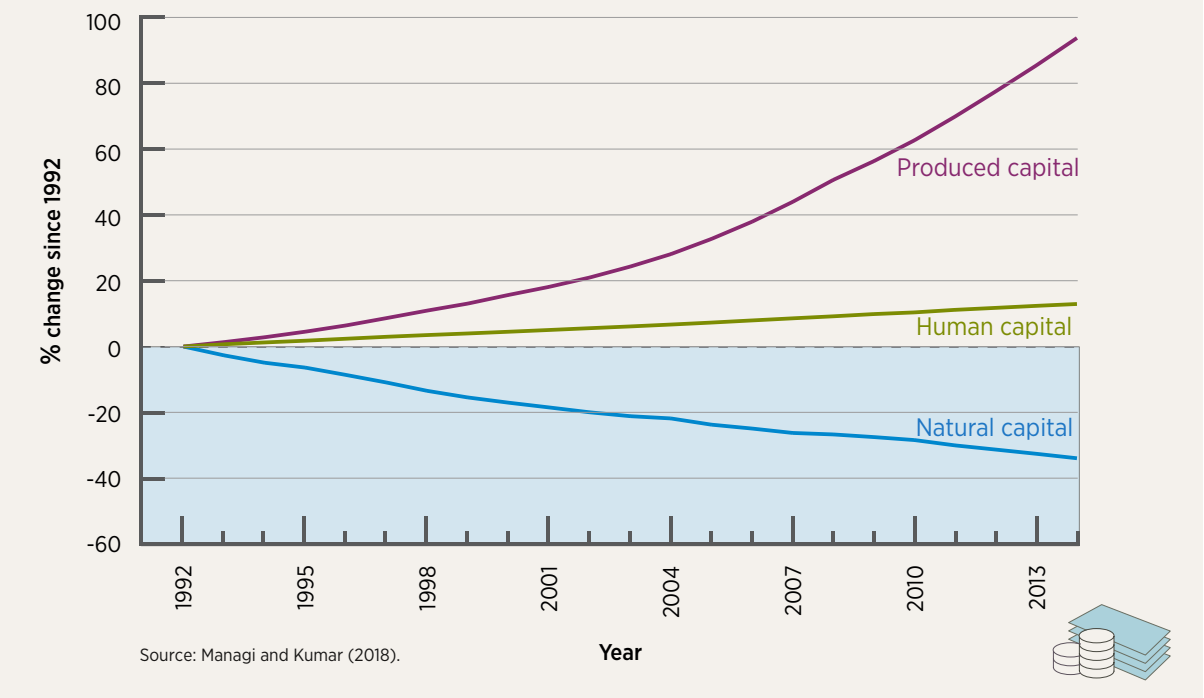
[21] *IPBES (2020) Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services.*

[22] *IPBES (2020) Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services.*

[23] *Millennium Ecosystem Assessment. (2005). Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.*

[24] *IPBES (2019), Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages.*

Figure 3. Global wealth per capita



Note: From Dasgupta, P. (2021), The Economics of Biodiversity: The Dasgupta Review. (London: HM Treasury)

There are limits to the goods and services nature can provide. Hence, because the biosphere is bounded, so are our economies. In the past century, humans have on average increased our standard of living (there are however important inequalities across the globe). But in the process, they have degraded the biosphere. As presented in Figure 3, the increase in produced capital has evolved hand in hand with the decrease in natural capital (ecosystems and resources). Today, our societies and economies use more of nature's goods, services and resources that it can renew each year.

The downward trend of natural capital poses a major risk to our societies: tipping points could be reached and have unforeseeable effects on human and produced capital, including on human health, well-being and global political stability.

Ecosystem services are often seen as a "free" gift from nature because one does not pay for them. This vision fails to see that, for most ecosystem services, no artificial alternative exists at the same scale, while restoring ecosystems and their services can be more costly than preserving them, provided restoration is possible at all. It has been estimated that, from 1997 to 2011, the world has lost between USD4.3 to 20.2 trillion annually in ecosystem services, due to land-cover and land-use changes (*e.g.* deforestation, conversion of wetlands and other natural areas).[25] Another estimate found that

[25] *Costanza, R., De Groot, R., Sutton, P., Van der Ploeg, S., Anderson, S. J., Kubiszewski, I., ... & Turner, R. K. (2014). Changes in the global value of ecosystem services. Global environmental change, 26, 152-158.*

poor ocean management practices (such as overfishing and pollution) cost over USD200 billion annually (and much more if impacts from climate change are taken into account).[26] Even when some artificial alternatives to some ecosystem services may exist, they are either very costly or would not be scalable to a global dimension (*e.g.* hand pollination for food production), as presented in Table 1. Hence, safeguarding/protecting ecosystems' health and biodiversity is crucial to our survival.

One main reason why ecosystem services are incorrectly valued in economic arbitrations is that they often fall into the category of public goods, meaning that they can be consumed simultaneously by many people, without warding off others from consuming them. As George Heal writes:

"If New York City cleans its air, then this is a good provided for all New Yorkers, and not just for a specific few. Markets can't handle the efficient provision of public goods because you can't exclude from receiving them those who didn't pay for them, meaning that markets under-provide public goods relative to what is needed for economic efficiency."[27]

Certain economic mechanisms and tools have been developed to reward practices maintaining ecosystem services, such as Payment for Ecosystem Services (PES) programs and ecological accounting. In PES schemes for instance, farmers may receive payments conditional on implementing agro-ecological practices that will protect pollinators and store more carbon in the soil, or communities may receive compensations conditional on preserving mangroves and forests and not clearing the land for other uses such as agriculture or aquaculture.

Some questions however arise with the use of PES: what happens when the program stops, in the case where the payment is not made by direct users of the ecosystem service? Do PES schemes and other economic incentives for conservation lead to motivational crowding out, and consequently to opposite effects?[28] Are PES programs effective, and is there no leakage? Are PES programs additional if the only people or communities who enroll in a PES program are those that would have made conservation efforts even without the program, the scheme is unlikely to lead to much improvement in ecosystem services? More largely, research is ongoing on how to best design PES schemes, and on analyzing their effectiveness and impacts[29] and effectiveness of PES schemes. Further analysis is also needed on the question of financing PES programs and governance issues.

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[26] UNDP and GEF (2012), Catalyzing Ocean Finance, Volume I, Transforming Markets to Restore and Protect the Global Ocean.

[27] Heal, G., (2020), The economic case for protecting biodiversity, NBER Working Paper Series 27963.

[28] Indeed, it has been argued that PES programs may lead to motivational crowding out: once people get paid for conservation, the motivation can become financial and crowd out initial, altruistic or intrinsic motivation for conservation, resulting possibly in opposite effects, in particular when the PES program stops. Whether PES schemes lead to motivational crowding out is still a debated and investigated question. See for instance Chervier, C., Le Velly, G., & Ezzine-de-Blas, D. (2019). When the implementation of payments for biodiversity conservation leads to motivation crowding-out: a case study from the Cardamoms forests, Cambodia. Ecological Economics, 156, 499-510. and Ezzine-de-Blas, D., Corbera, E., & Lapeyre, R. (2019). Payments for environmental services and motivation crowding: towards a conceptual framework. Ecological economics, 156, 434-443.

[29] Börner, J., Baylis, K., Corbera, E., Ezzine-de-Blas, D., Honey-Rosés, J., Persson, U. M., & Wunder, S. (2017). The effectiveness of payments for environmental services. World development, 96, 359-374.

Table 1. Examples of direct contributions of ecosystems to the economy

Ecosystem Service	Magnitude of the economic contribution	What we would need to pay for in the absence of biodiversity.
Crop Pollination (food)	Lower bound: $500 billion annually.	No alternative at scale. Rental of beehives, hand pollination, drones.
Provision of marine products from fisheries and aquaculture (food)	$362 billion (first sale value of fisheriesand aquaculture).	
Carbon Storage & Capture (climate)	Lower bound for forests: $262 billion annually for a price on carbon of only $35.	No alternative at scale. Carbon capture and storage at a lower scale.
Provision of water and purification (watersheds)	No estimation at global level to our knowledge. In the mid 90s, the city of New York paid $1.5 billion to restore a watershed that was delivering a service worth $9 billion.	Up to a certain level, filtration plants.
Genetic Resources: Food Security	Within species diversity provides insurance against pests, diseases and climatic change (*e.g.* droughts).	Genetically Modified Organisms, with no insurance on the health and environmental consequences.
Genetic Resources: Medicine	Approximately one third of medicines were discovered in plants, insects, or animals. New treatments are still to be discovered within nature.	N/A
Genetic Resources: Protection against viruses	The multiplication of zoonotic diseases[30] (Ebola, SARS, HIV, Zika, maybe Covid-19) are increasingly occurring as we make new incursions in natural areas through overexploitation of resources, poaching and hunting. 30% of new diseases are due to land-use change.[31]	N/A
Cultural services	• Tourism relies directly on rich biodiversity and ecosystems. Ex: coral reef tourism: $36 billion annually • Knowing that species are disappearing and that the environment is being degraded has deep and still uncovered psychological consequences, also known as solastalgia[32] and eco-anxiety.	N/A

Sources: Heal, G., (2020), The economic case for protecting biodiversity. NBER Working Paper Series 27963 OECD (2019). Biodiversity: Finance and the Economic and Business Case for Action, report prepared for the G7 Environment Ministers. Meeting, 5-6 May 2019. Spalding, M., Burke, L., Wood, S. A., Ashpole, J., Hutchison, J., & Zu Ermgassen, P. (2017). Mapping the global value and distribution of coral reef tourism. Marine Policy, 82, 104-113.

[30] *Zoonotic diseases are diseases that are transmitted from animals to humans.*

[31] *Convention on Wetlands (2021). Global Wetland Outlook: Special Edition 2021. Gland, Switzerland: Secretariat of the Convention on Wetlands.*

[32] *See Glenn Albrecht's work.*

Note: Different methods exist for valuing ecosystem services, and many different estimates exist.[33] Despite some degree of uncertainty in estimates, this table aims mainly at providing an order of magnitude of the contribution of ecosystem services to our societies and economies (*i.e* these values should not be considered as exact values). It should also be noted that in such valuations, the « value » taken into account:.

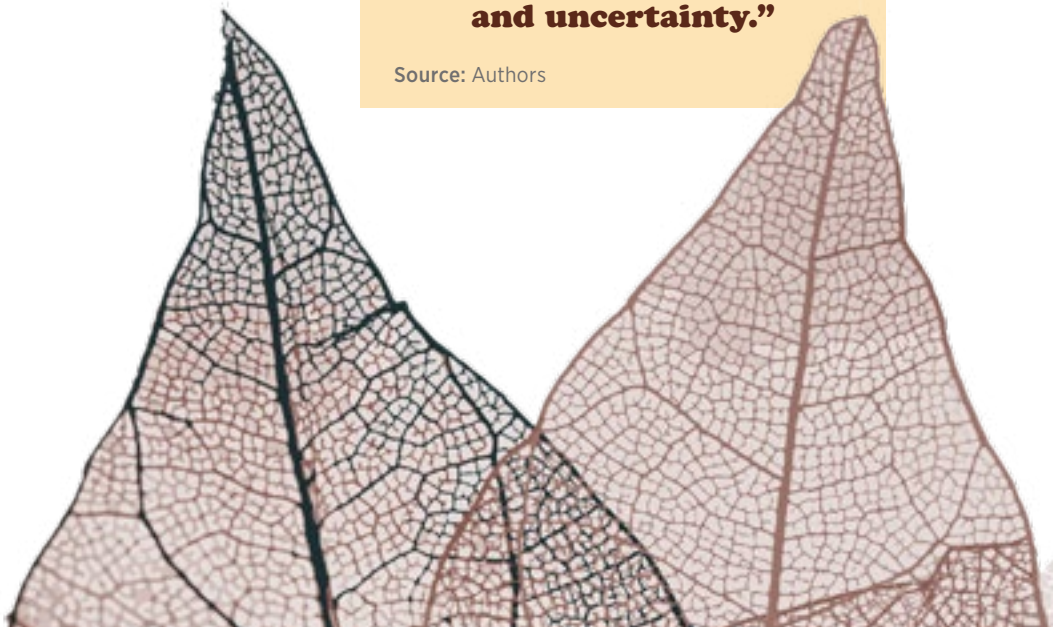
- is generally an « instrumental value » (not necessarily reflecting or taking into account the intrinsic value of nature i.e. the idea that nature has a value per se, beyond the use than can be made of it),
- should be understood as the value for humans (not necessarily considering other living species). The goal here is not and should not be to put a price on nature it is important to distinguish price and value.

For an extensive discussion on the value of biodiversity, see for instance the report of the Foundation for Research on Biodiversity.[34]

It appears that we are now crossing the tipping points that will make degradation of natural capital much more costly, and a constant source of both instability and uncertainty. The same living habits (in particular consuming practices) we have had in the past decades can no longer be maintained because of the ever-rising pressures they exert on biodiversity.

"We are now crossing the tipping points that will make degradation of natural capital much more costly, and a constant source of both instability and uncertainty."

Source: Authors



[33] *Some valuations can be useful to compare the restoration costs of an ecosystem (e.g. a watershed) to the cost of an alternative (e.g. construction of a new water-treatment station). Other approaches focus on evaluating the consequences of inaction (e.g. not protecting or restoring an ecosystem). For more details on different evaluation approaches, see the report referenced in the following footnote.*

[34] *Maitre d'Hôtel E., Pelegrin F. (2012). Les valeurs de la biodiversité: un état des lieux de la recherche française. Rapport FRB, série expertise et synthèse, 2012, 48 pages.*

3. THE SIXTH MASS EXTINCTION HAS STARTED

Biodiversity is one of the 9 categories of planetary boundaries identified and anlysed by the Stockholm Resilience Institute since 2009.[35] **Planetary boundaries are defined as thresholds that, if crossed, may have considerable consequences by triggering "non-linear, abrupt environmental change within continental-scale to planetary-scale systems".**[36] In short, disrespecting planetary boundaries increases the risk of facing societal shocks of high magnitude that would have serious geopolitical consequences.

The loss of biodiversity integrity (genetic and functional diversity) is one of the boundaries that has already been crossed, alongside land-use change (*e.g.* deforestation or wetlands conversion), introduction of novel entities (*e.g.* harmful chemicals such as pesticides, or plastics), altered biogeochemical cycles (*e.g.* excess use of fertilisers), and climate change.[37,38]

3.1. Biodiversity collapse can be measured in complementary ways:

SPECIES DIVERSITY

- **Species extinction: Out of the 8 million species on Earth (lower bound), about 1 million are threatened with extinction in the coming decades.**[39] Species' threat status are referenced within the IUCN Red List, which ranks all known species on a scale from "Extinct" to "Least Concerned". New species evolve over time and disappear naturally, yet the current rate of extinction is hundreds to thousands of times higher than the natural rate of extinction.

Above these three scales, loss in biodiversity means degradations of interactions among ecosystems (among all living organisms), that can cross thresholds and induce fundamental changes that we are not able to foresee.

GENES DIVERSITY

- **Populations decline: Since 1970, it is estimated that about two thirds of vertebrate populations have been lost**[40]**, resulting in a loss in genes' diversity among these species.** This decline in populations is widespread and threatens global peace and stability the most directly, as it is directly correlated to the decrease of ecosystem services.

ECOSYSTEMS DIVERSITY

- **Ecosystems loss:** Forests, wetlands, coral reefs, meadows, mountain glaciers or continental ice sheets are all examples of ecosystems the extent and quality of which are declining sharply. **The extent of natural wetlands declined by 35% between 1970 and 2015**[41]**, while the world has lost about one-third of its forests since the birth of civilisation.**[42]

[35] *Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Lambin, E. F., ... & Foley, J. A. (2009). A safe operating space for humanity. nature, 461(7263), 472-475.*

[36] *Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin III, F. S., Lambin, E., ... & Foley, J. (2009). Planetary boundaries: exploring the safe operating space for humanity. Ecology and society, 14(2).*

[37] *Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., ... & Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. Science, 347(6223), 1259855.*

[38] *Persson, L., Carney Almroth, B. M., Collins, C. D., Cornell, S., de Wit, C. A., Diamond, M. L., ... & Hauschild, M. Z. (2022). Outside the Safe Operating Space of the Planetary Boundary for Novel Entities. Environmental science & technology.*

[39] *IPBES (2019), Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages.*

[40] *WWF (2020) Living Planet Report 2020 - Bending the curve of biodiversity loss. Almond, R.E.A., Grooten M. and Petersen, T. (Eds). WWF, Gland, Switzerland.*

[41] *Convention on Wetlands (2021). Global Wetland Outlook: Special Edition 2021. Gland, Switzerland: Secretariat of the Convention on Wetlands*

[42] *Ritchie, H. and Roser, M. (2021) - «Forests and Deforestation». Published online at OurWorldInData.org. Retrieved from: https://ourworldindata.org/deforestation.*

Scientific literature is better established on mammals, amphibians and birds as their population counts are easier to track. However, recent research shows that the situation is equally concerning for invertebrates (insects, mollusks), as well as for plants' and microorganisms' diversity. Birds and mammals represent only a small portion of known animal species: the number of described mollusks and insect species is far greater. The latest scientific studies conclude that the rate of extinction of invertebrate species is even higher than previously estimated. A German study focusing on protected areas for which data was collected for the past three decades showed that more than 75% of total insect biomass has been lost in Europe.[43] Recent news also came out on mollusks, and "possibly as many as 7.5–13% of all 2 million known species have already gone extinct, orders of magnitude greater than the 882 (0.04%) on the Red List".[44]

As biodiversity and ecosystem services fade away, we risk losing our collective memory of it, a phenomenon sometimes called 'ecological amnesia'. As our baseline of what is richness of life is sliding down decade after decade, there is a risk that awareness and ambitious mobilisation become more difficult. Hence the accent should be put on education on biodiversity and opportunities to regenerate it.

Biodiversity decline tends to receive limited media coverage. it is mostly a silent and progressive crisis, even at the unprecedented speed of loss we are experiencing. As paradoxical as it may seem, past mass extinctions were not characterised by hecatombs: if it was the case, sedimentary layers* corresponding to the extinction periods would be filled with large amounts of fossils. Instead, these layers are mostly empty, which illustrates that crises happened progressively over thousands of years, and were due to global deteriorated conditions of living. This deterioration led to species' population degrowth generation after generation, which ended up in chain extinctions. As Bruno David writes: "We don't walk on dead sparrows in Paris, even though their numbers have halved over the past 15 years".[45]

"Past mass extinctions were not characterised by hecatombs: crises happened progressively over thousands of years, and were due to global deteriorated conditions of living."

Source: Authors

[43] *Hallmann, C. A., Sorg, M., Jongejans, E., Henk, S., Hofland, N., Schwan, H., ... Kroon, H. (2017). More than 75 percent decline over 27 years in total flying insect biomass in protected areas. PLoS One, 12, e0185809.*

[44] *Cowie, R. H., Bouchet, P., & Fontaine, B. (2022). The Sixth Mass Extinction: fact, fiction or speculation?. Biological Reviews, 97.*

[45] *Bruno David, author of the book A l'aube de la sixième extinction, comment habiter la Terre (Editions Grasset), in an interview for Les Echos: Les Echos (2021). Bruno David: "La vitesse d'extinction des espèces est inédite". Retrieved from: https://www.lesechos.fr/weekend/perso/bruno-david-la-vitesse-dextinction-des-especes-est-inedite-1314924.*

3.2. Why and how is biodiversity collapsing?

3.2.1. Introducing the five drivers of biodiversity loss

Biodiversity collapse is due to 5 main drivers of loss (Figure 4) , ranked by order of magnitude:

1. Land / Sea Use Change: intensively occupying and converting to human use large areas through deforestation, soils artificialization, drainage of wetlands or seagrass loss (marine equivalent of deforestation) is the most impactful driver of biodiversity loss in terrestrial and freshwater habitats.

2. Overexploitation of resources: overfishing, overuse of water, or wildlife hunting and trade. This driver is ranked second by the IPBES for terrestrial and freshwater biodiversity, and first for marine life.

Figure 4. Contribution of direct and indirect drivers of biodiversity loss

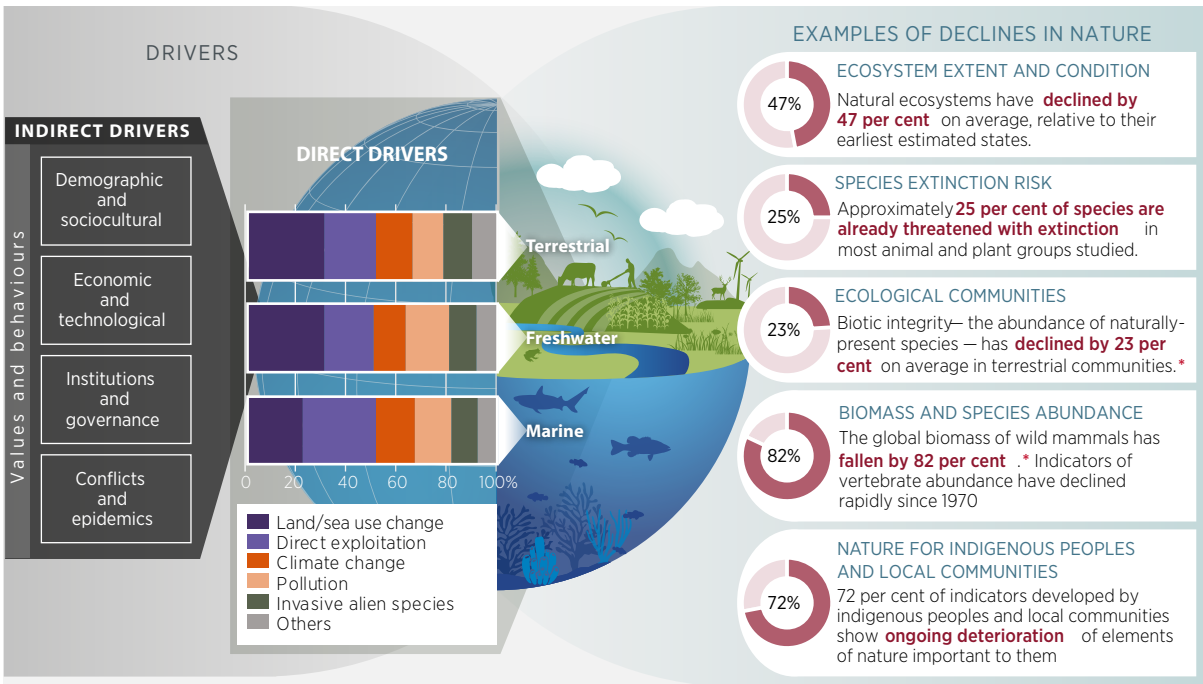


Figure SPM 2 Examples of global declines in nature, emphasizing declines in biodiversity, that have been and are being caused by direct and indirect drivers of change.

The direct drivers (land-/sea-use change; direct exploitation of organisms; climate change; pollution; and invasive alien species)[7] result from an array of underlying societal causes.[8] These causes can be demographic (e.g., human population dynamics), sociocultural (e.g., consumption patterns), economic (e.g., trade), technological, or relating to institutions, governance, conflicts and epidemics. They are called indirect drivers[9] and are underpinned by societal values and behaviours. The colour bands represent the relative global impact of direct drivers, from top to bottom, on terrestrial, freshwater and marine nature, as estimated from a global systematic review of studies published since 2005. Land- and sea-use change and direct exploitation account for more than 50 per cent of the global impact on land, in fresh water and in the sea, but each driver is dominant in certain contexts {2.2.6}. The circles illustrate the magnitude of the negative human impacts on a diverse selection of aspects of nature over a range of different time scales based on a global synthesis of indicators {2.2.5, 2.2.7}.

Source: IPBES (2019), Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages.

3. Climate Change: comes only at the third place as global warming is still nascent, but is expected to be far more impactful as temperatures rise and ecosystems' thresholds are crossed.

4. Pollution: is caused by harmful substances, excess of nutrients, solid and plastic waste, light and noise. These pollutions cause the following phenomena, among others:

- *Eutrophication:* excess of nitrogen and phosphorus fertilisers nurture algal blooms which proliferate and deplete oxygen stock in water frequently resulting in the development of toxic algae. Eutrophication has devastating effects on freshwater and marine ecosystems, creating entire 'dead zones'. Terrestrial ecosystems are also impacted by excess of nutrients, which slows soils' microbial growth.[46]
- *Acidification:* Water acidification is also reinforced by the excess of atmospheric CO_2 in water, which disintegrates through chemical reactions when it enters in contact with water. Terrestrial ecosystems and in particular soils are also impacted by acidification, *e.g.* forests in Sweden, Finland, France, etc.
- *Ecotoxicity:* spreading in the environment of chemicals that are toxic to ecosystems, such as neonicotinoids or other pesticides and fungicides. Common toxicants also include oil, bisphenol A, phosphates, cleaning products, and others.
- *Disturbances:* infrastructures may destabilise the natural functioning of ecosystems, which can be mitigated if managed properly. These impacts should not be underestimated: for instance the day-night cycle has been a stable dynamic on Earth for billions of years, therefore disturbing it can have multiple effects ranging from physiological changes and habitat fragmentation to the disturbance in the predator-prey relationships.

5. Invasive alien species: introducing new species in an environment where it was not present before can be destabilising for the ecosystem, with famous examples such as the Asian hornet or the Louisiana crawfish in Europe.

"Introducing new species such as the Asian hornet in an environment where it was not present before can be destabilising for the ecosystem."

Source: Authors

Just as mitigating climate change requires reducing emissions from the different greenhouse gas emissions (carbon dioxide, methane, nitrogen dioxide, etc.), **reversing biodiversity loss requires reducing the pressures originating from these five drivers that are exerted over ecosystems.**

[46] *IPBES, Models of drivers of biodiversity and ecosystem change, Retrieved from: https://ipbes.net/models-drivers-biodiversity-ecosystem-change (consulted in January-March 2022).*

These direct drivers are closely interlinked with indirect ones, that are demographic and sociocultural, economic and technological, linked to our institutions and governance, and to the conflicts and epidemics happening on Earth. To address the direct drivers, the IPBES clearly documents the necessity for a 'transformative change', that can be reached through a broad mobilisation of different types of actors and means ("leverage points" in the Figure below). The change required to preserve and restore biodiversity is transdisciplinary, trans-sectoral and trans-boundaries. Further details on several 'leverage points' are given in the second part of this report.

Figure 5. zoom on the indirect drivers of biodiversity loss

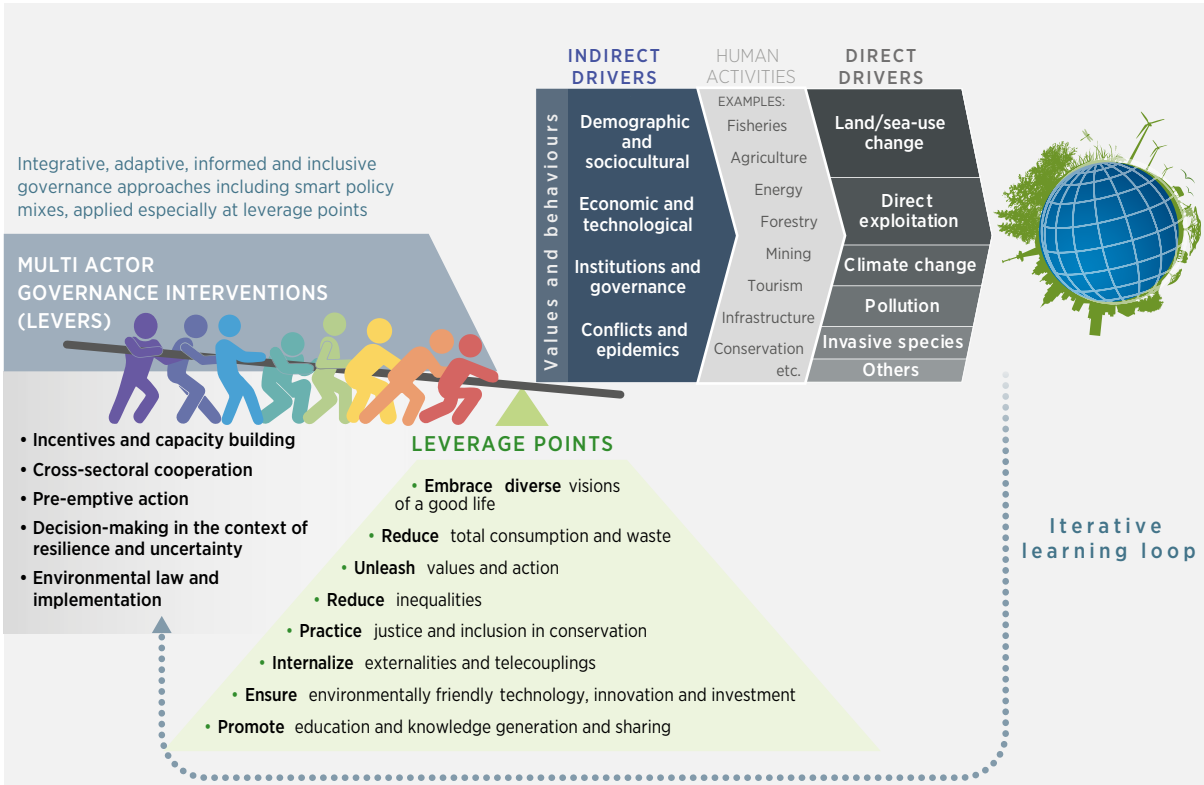


Figure SPM 9 **Transformative change in global sustainability pathways.**

Collaborative implementation of priority governance interventions (levers) targeting key points of intervention (leverage points) could enable transformative change from current trends towards more sustainable ones. Most levers can be applied at multiple leverage points by a range of actors, such as intergovernmental organizations, governments, non-governmental organizations, citizen and community groups, indigenous peoples and local communities, donor agencies, science and educational organizations, and the private sector, depending on the context. Implementing existing and new instruments through place-based governance interventions that are integrative, informed, inclusive and adaptive, using strategic policy mixes and learning from feedback, could enable global transformation.

Source: IPBES (2019), Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages.

3.2.2 Contribution of economic activities to the drivers of biodiversity loss

Economic activities directly contribute to the five drivers of biodiversity loss that have been identified by the IPBES:

Table 2. Drivers of biodiversity loss and relation to economic sectors (non-exhaustive)

Drivers of biodiversity Loss[47]	Economic Sectors Most Concerned	Explanation
Land Use & Land Use Change	Agriculture	•Demand for land leading to deforestation and conversion (notably animal products and commodities such as oil palm) •Intensive use of agricultural lands with little on-field biodiversity
	Forestry	•Deforestation for exotic wood trade •Conversion of natural habitats for tree harvesting
	Extraction of raw materials	•Conversion of natural habitats for mining •High ecosystem disturbances during exploitation
	Construction	•Artificialization of soils for commercial and residential development (housing, commercial and industrial areas, tourism and recreational areas)
	Transportation	•Transportation corridors which fragment habitats
Overexploitation of Resources	Fishing	•Fishing rates largely surpass natural fishing stocks renewal •Fishing methods that endanger whole ecosystems and increase the risks of bycatch (trawling, electric fishing, etc.)
	Wildlife trade	•Trade of endangered species •Viruses and diseases spread between species
Overexploitation of Resources	Agriculture	•Water overexploitation in water scarce areas
	Textile	
	Forestry	•Unsustainable wood logging and harvesting

[47] *As defined in: IPBES (2019), Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages.*

Climate Change	Energy	•High contribution to greenhouse gas (GHG) emissions
	Transport	
	Agriculture	
	Industry	
	Construction	
Pollution	Agriculture	•Fertilisers use causing eutrophication •Pesticides and fungicides use spreading ecotoxic chemicals in the environment
	Chemical Industry	•Selling of ecotoxic products •Water effluents spreading exotoxic chemicals
	Textile Industry	•Water effluents spreading exotoxic chemicals
Invasive Alien Species & Others	International Transportation	•Displacement of species can cause significant disequilibrium of ecosystems.
	Agriculture	•Introduction of pesticide-resistant crops or genetically-modified insects •Introduction of invasive plants

Note: Classification is partially based on: Stephenson, P.J. and Carbone, G. (2021), Guidelines for planning and monitoring corporate biodiversity performance. Gland, Switzerland: IUCN.

4. CLIMATE CHANGE AND BIODIVERSITY LOSS: RESOLVING THE "TWIN CRISES"

Biodiversity and climate change are two sides of the same coin. Climate regulation and climate change adaptation are two of the essential services provided by ecosystems. Conversely, climate change is one of the pressures identified on biodiversity by the IPBES.

4.1. Mitigating climate change requires healthy ecosystems

Terrestrial ecosystems have the ability to absorb carbon out of the atmosphere, and store it either underground (*e.g.* within soils) **or aboveground** (*e.g.* within trees' trunk and leaves, seagrass).

This is also true for marine ecosystems. As an example, one single whale captures the same amount of carbon as about 1,000s of trees. During their life, whales boost phytoplankton growth as their feces acts as a fertiliser (phytoplankton absorb 40% of global carbon carbon emissions), and when it dies, the whale sinks and takes a large amount of carbon with it to the bottom of the ocean.

This implies that ecosystems of paramount importance for climate change mitigation: preserving the carbon stocks that were accumulated overtime (**carbon stocks**), and enhancing their capacity to keep absorbing carbon out of the atmosphere (**carbon sinks**). Other key services, such as the adaptation to local heatwaves (*e.g.* trees refreshing their surroundings in cities) could help reduce the energetic demand for services such as air conditioning.

Climate change mitigation relies on healthy ecosystems that are able to act as carbon sinks. The IPCC's net-zero trajectories[48], which are global pathwaysto follow to halt global warming by 2050, call for two types of actions: a drastic reduction in emissions, as well as an increase in carbon sequestration. In that regard, undermining or even destroying healthy carbon-rich ecosystems (*e.g.* wetlands, forests, meadows) is highly detrimental to climate as it may:

1. **Release large amounts of stored carbon in the atmosphere** and,
2. **Prevent the ecosystems from storing further carbon** by disrupting their functionalities.

Carbon-rich ecosystems most often correspond to key biodiversity areas. As climate change impacts ecosystems, they are likely to release carbon out in the atmosphere: snow-ball effects are likely to arise. Under a "business as usual" scenario, *i.e.* one where no ambitious action limiting global warming to 1.5°C is undertaken, **the increase in temperature would undermine the ability of ecosystems to act as carbon sinks, and could reduce by half their carbon uptake before mid century.**[49, 50] There is a risk of crossing tipping points as part of the carbon-rich ecosystems shift from being carbon sinks to net emitters of carbon.

[48] *Net-zero trajectories are scenarios that set the world on a 2050 balance between carbon emissions and carbon absorptions, with the aim to halt climate change after mid century.*

[49] *Deprez, A. et al. (2021). Aligning high climate and biodiversity ambitions in 2021 and beyond: why, what, and how? IDDRI, Study N°05/21.*

[50] *Duffy, K. A., Schwalm, C. R., Arcus, V. L., Koch, G. W., Liang, L. L., & Schipper, L. A. (2021). How close are we to the temperature tipping point of the terrestrial biosphere?. Science advances, 7(3), eaay1052.*

In that sense, Conservation International lately introduced the concept of "**Irrecoverable Carbon**", referring to "**the vast stores of carbon in nature that are vulnerable to release from human activity and, if lost, could not be restored by 2050** - when the world must reach net-zero emissions."[51]

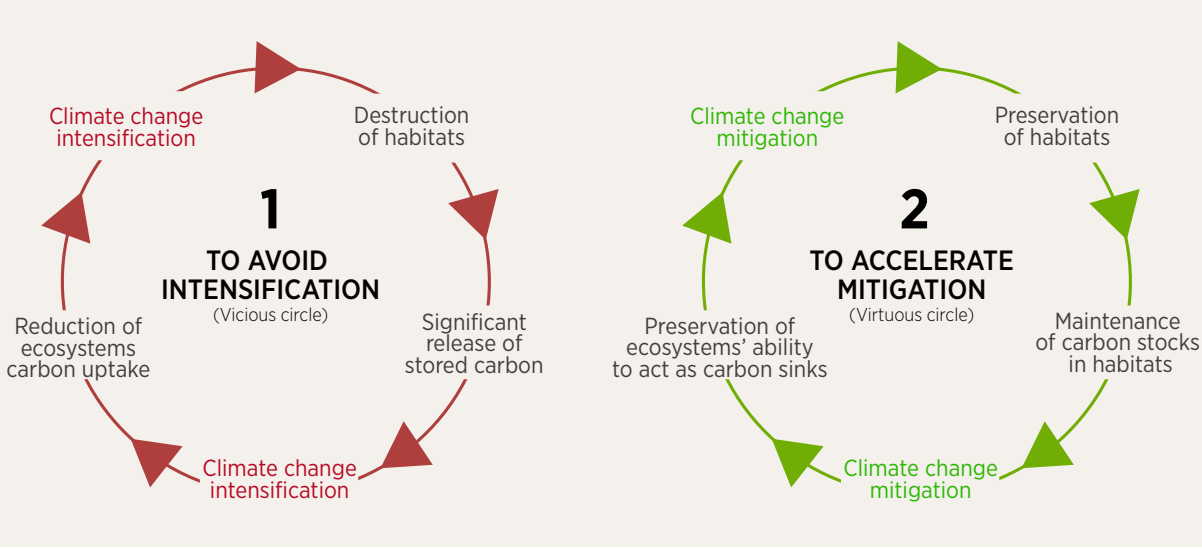
In a recent study published in Nature[52], Conservation International finds that irrecoverable carbon is highly concentrated, half of it being located "on just 3.3% of land - primarily old-growth forests, peatlands and forests". Not only this, areas hosting irrecoverable carbon can be considered "doubly irreplaceable", as "75% of irrecoverable carbon provides habitat for 91% of its terrestrial vertebrate species".

Therefore, "targeted conservation would yield big gains: increasing the land under protection by just 5.4% in key areas would keep 75% of irrecoverable carbon from being released into the atmosphere."

Peatlands form the most carbon-intensive ecosystem per ha: they only occupy 3% of the Earth, but are estimated to store about a third of the global carbon stored in soils.

Source: WWF France. (2022). Savanes, prairies, mangroves... les grands sacrifiés de l'UE

Figure 6. Climate change mitigation needs biodiversity



Source: Authors realization

[51] *Conservation International. (n.d.). Irrecoverable Carbon. Retrieved from: https://www.conservation.org/projects/irrecoverable-carbon*

[52] *Noon, M. L., Goldstein, A., Ledezma, J. C., Roehrdanz, P. R., Cook-Patton, S. C., Spawn-Lee, S. A., ... & Turner, W. R. (2022). Mapping the irrecoverable carbon in Earth's ecosystems. Nature Sustainability, 5(1), 37-46.*

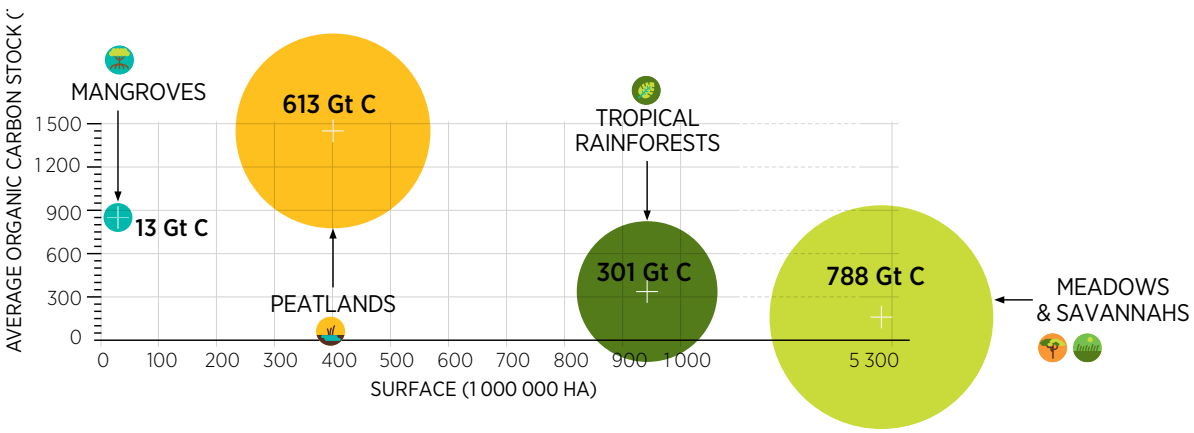
4.1. Forests are not the only ecosystems to contribute to climate change mitigation

Wetlands, meadows and savanna should be recognised, alongside forests, as top preservation priorities. In fact, tropical forests are neither the most carbon-rich ecosystem per hectare, nor do they contain the most carbon in global absolute values among terrestrial ecosystems (see Figure 7).

Figure 7 helps understand the crucial role that other ecosystems than tropical forests play:

- **Peatlands[53] form the most carbon-intensive ecosystem per ha: they only occupy 3% of Earth' surface area, but they are estimated to store about a third of the global carbon stored in soils.[54] In fact, the draining of peatlands is responsible for about 4% of anthropogenic greenhouse gas emissions**, which is comparable to the emissions of the aeronautic sector.[55]
- **In terms of carbon storage intensity per ha, meadows and savannas store about half as much carbon as tropical forests per ha while occupying a very large surface area (about 5 times more).**
- **Mangroves[56] are the second most carbon-intensive ecosystem per ha,** far beyond meadows, savannas, and tropical forests. If mangroves occupy only a small portion of the planet, they form a significant carbon sink and are crucial to coastal human communities as they offer protection from floods and erosion, and shelter a great variety of life that is key to fisheries.

Figure 7. Carbon Stocks are distributed between wetlands, forests, meadows and savannas



Note: these values are averages, and may differ greatly depending on the local biodiversity and climatic conditions.

Source: WWF France. (2022). Savanes, prairies, mangroves... les grands sacrifiés de l'UE. Sources are detailed in Table 2 of Annex 1 of the report, page 47.

[53] *Peatlands are wetlands that can be found in more than 180 countries. Their composition and vegetation vary across regions.*

[54] *WWF France. (2022). Savanes, prairies, mangroves... les grands sacrifiés de l'UE.*

[55] *Joosten et al. (2016); Leifeld et al. (2019) and Günther et al. (2020) in: Convention on Wetlands (2021). Global Wetland Outlook: Special Edition 2021. Gland, Switzerland: Secretariat of the Convention on Wetlands.*

[56] *Mangroves can be found in coastal parts of tropical or subtropical climates. They are made of iconic trees that have parts of their roots bathing in salty water with low oxygen volumes, and other aerial roots that absorb oxygen directly from the air, while their leaves allow them to excrete salt.*

All types of carbon storage are not equivalent: preserving a greater diversity of carbon sinks can be seen as a risk mitigation strategy. One aspect that adds to the crucialness of not only preserving forests but also wetlands, meadows and savannas, is what we will call here ***'carbon safety'.*** Indeed, most carbon is trapped under the surface of the soil within peatlands, meadows and savannas, and mangroves (respectively about 98%, 80% and 68%[57]), whereas forests store more than half of carbon above the surface of the soil (see Figure 8).

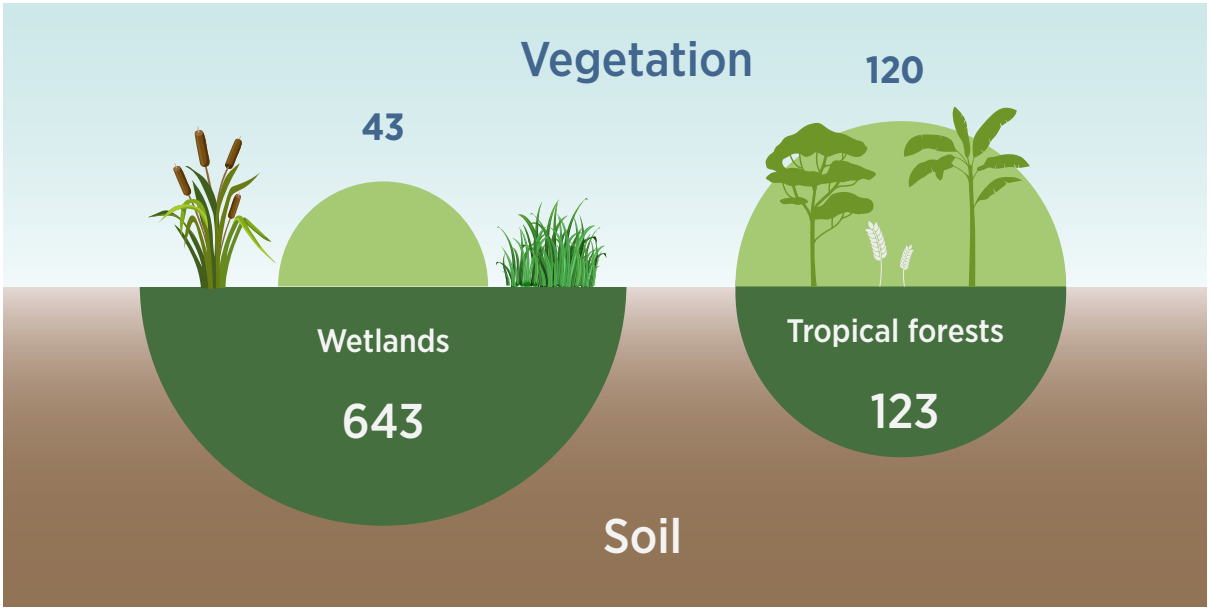
The fact that forests store the majority of carbon above the surface of the soil makes them vulnerable to wildfires or droughts. Recurring wildfires, sometimes called 'megafires', which are now occurring frequently in California, Australia, Amazonia, Central Africa or even Siberia, are set to release ever-rising amounts of carbon into the atmosphere. Hence the need to protect other carbon-rich ecosystems.

All in all, as IDDRI underlines:[58]

"Preserving and restoring biodiversity should be understood not as an 'add-on' to climate action but a necessary condition to reach net-zero CO_2 emissions."

Source: Deprez, A *et al.* (2021)

Figure 8. Carbon storage in T per hectare, with soil/vegetation breakdown



Source: Illustration based on IPCC and NASA data, taken from: Neufeld, D. and Smith, M. (2022). Visualizing carbon storage in Earth's ecosystems. Visual Capitalist, retrieved from: https://www.visualcapitalist.com/visualizing-carbon-storage-in-earths-ecosystems/

[57] *Ibid.*

[58] *Deprez, A. et al. (2021). Aligning high climate and biodiversity ambitions in 2021 and beyond: why, what, and how? IDDRI, Study N°05/21.*

Box 2

Our civilisation and agricultural system have been based on a stable climate

Climate change is pushing the Earth out of the 'Holocene' geological era, which was characterised by stable temperatures for the past 10,000 years. Climate change is destabilising the functioning of ecosystems that were adapted to the rhythm of **seasons under a stable range of temperatures specific to each local climatic zone.**

The 'Holocene' era allowed the development of the sedentary civilisation as we know it. Exiting the Holocene threatens our way of life and is putting our agricultural resilience at risk. Stable temperatures allowed humans to specialise our diets and select only a portion of species to feed ourselves, as seasons and temperatures were predictable under an acceptable range of uncertainty. Selecting only a portion of crops to feed ourselves has reduced our resilience to shocks and consequently significant changes in climate.

Only 12 plants and 5 animal species make up 75% of the world's food[a], and within each species grown, the genetic diversity has decreased to foster optimisation and standardisation. "Since the 1900s, some 75 percent of plant genetic diversity has been lost as farmers worldwide have abandoned their multiple local varieties for genetically uniform, high-yielding varieties", and "30% percent of livestock breeds are at risk of extinction", with six breeds being lost each month[a]. This statement also holds true for the textile industry: 11 species produce around 95% of the world's demand for natural fibers. For instance, cotton, which is by far the most widespread natural fiber used (around 80% of the world's production of natural fibers), only 4 out of the 50 known species of cotton are cultivated, and one of these 4 represents 90% of the cotton production.

The lack of genetic diversity is a matter of security and resilience, as crops' genetic diversity is a necessary adaptation lever to face environmental shocks such as the increase in droughts, diseases and decline of ecosystem services that come along climate change. As written in the March 2022 IPCC Report: "Global warming will progressively weaken soil health and ecosystem services such as pollination, increase pressure from pests and diseases, and reduce marine animal biomass, undermining food productivity in many regions on land and in the ocean"[d].

[a] *FAO. What is happening to agrobiodiversity? Retrieved from: https://www.fao.org/3/y5609e/y5609e02.htm (consulted in January-March 2022).*

[b] *FAO. What is happening to agrobiodiversity?*

[c] *FAO. (2021). Recent trends and prospects in the world cotton market and policy developments. Rome. https://doi.org/10.4060/cb3269en.*

[d] *High confidence, see: IPCC. (2022). Summary for Policymakers [H.-O. Pörtner, D.C. Roberts, E.S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem (eds.)]. In: Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. In Press.*

Climate change has already caused "substantial damage" and "increasingly irreversible losses"[59] to biodiversity. These impacts are "larger than estimated in previous assessments".

Species are exposed to new temperatures that exceed their 'upper thermal limit'.[60] Given the climatic conditions that presided over the evolution of the species, their organisms tolerate a range of temperatures composing their "thermal niche".

For instance, exposure to temperatures higher than 35°C under high humidity conditions, or close to 50°C with low humidity can be lethal to the human body and pigs, poultry or agricultural crops such as wheat, maize or rice.[61]

"The structure and function, resilience and natural adaptive capacity" of ecosystems are already deteriorated, while "shifts in seasonal timing" occur due to climate change.[62] Ecosystems key to climate change mitigation and adaptation are among the most impacted: "**combined with non-climatic drivers, (global warming) will cause loss and degradation of much of the world's forests, coral reefs and low-lying coastal wetlands".**[63]

For instance, one recent study from the Stockholm Resilience Center found that up to 40% of the Amazon forest could turn into a savanna by the end of the century, therefore releasing carbon in the atmosphere and worsening the extreme heat events' impacts on inhabitants of the region. 'Savannization' occurs as the dry season gets longer each decade and deforestation keeps gaining ground, thresholds are being crossed. Tropical forests rely on their ability to enhance rainfalls during dry seasons by extracting soil moisture or groundwater and releasing it into the atmosphere through evapotranspiration. Therefore, water can re-evaporate and rain down multiple times. But such regional water cycles cannot be sustained anymore as droughts become too frequent and forests are receding.

Species located around the Equator are the most at risk of exposure to temperatures outside of their thermal niche.[64] This may appear paradoxical, as warming is more intense around poles and tropics. However, species along the Equator are used to a lower magnitude of temperatures variability and are therefore more vulnerable to climate change. The impacts on Equatorian ecosystems are likely to have repercussions in other parts of the world, For instance, a potential shift of the Amazon into a savannah that may affect the global climate system.

"40% of the Amazon Forest could turn into a Savanna by the end of the century, therefore releasing carbon in the atmosphere and worsening the extreme heat impacts on inhabitants of the region."

Source: Stockholm Resilience Institue

[59] *High confidence, see: IPCC. (2022). Summary for Policymakers . Cambridge University Press. In Press.*

[60] *High confidence, see: IPCC. (2022).*

[61] *Asseng, S., Spänkuch, D., Hernandez-Ochoa, I. M., & Laporta, J. (2021). The upper temperature thresholds of life. The Lancet Planetary Health, 5(6), e378-e385.*

[62] *High confidence, see: IPCC. (2022).*

[63] *High and very high confidence, see: IPCC. (2022).*

[64] *Trisos, C. H., Merow, C., & Pigot, A. L. (2020). The projected timing of abrupt ecological disruption from climate change. Nature, 580(7804), 496-501.*

Species that are most-climate sensitive have already started moving closer to poles, or experiencing changes in their behaviors.

For instance, in the past 30 years, European swallows have migrated 15 days later to Africa during winter, staying on the European coast of Mediterranean Sea due to higher temperatures. This puts European ecosystems at risk, as it may increase competition for food resources with non-migrating species during winter. Swallows themselves are also at risk, as they become exposed to risks of temperatures low temperatures that can still occur at any moment.[65]

When it comes to climate change impacts, "human and ecosystem vulnerability are interdependent" while "approximately 3.3 to 3.6 billion people live in contexts that are highly vulnerable to climate change".[66] Other human pressures on biodiversity exacerbate the effects of global warming: "globally, and even within protected areas, unsustainable use of natural resources, habitat fragmentation, and ecosystem damage by pollutants increase the environment's vulnerability to climate change".[67]

Protected areas are a key tool to lessen these repercussions and maintain the resilience of ecosystems. To achieve these goals, they need to be developped both in terms of quantity of protected land area and in terms of quality of protection**.** In fact, while at the moment "less than 15% of the land, 21% of the freshwater and 8% of the ocean are protected", approximately **"30% to 50% of Earth's land, freshwater and ocean areas" should be safeguarded.** Furthermore, "in most protected areas there is insufficient stewardship to contribute to reducing damage from, or increasing resilience to, climate change".[68]

The extension of protected areas, needed to reduce impacts on climate, is bound to compete with agricultural land expansion should diets not evolve.

Last but not least, increased CO_2 concentration as a result of human-induced emissions is also having an impact on oceans and freshwater ecosystems by leading to acidification (lowered pH). As it enters in contact with water, CO_2 dissolves into the ocean, releasing carbonic acid which contributes to acidification. Coral reefs are an example of a largely impacted ecosystem, as is"food production from shellfish aquaculture and fisheries in some oceanic regions".[69]

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[65] *Dulczewski, A. (2021). COP26: quand des oiseaux ne migrent plus jusqu'en Afrique, "comme si l'évolution se passait devant nos yeux". RTBF.be, retrieved from: https://www.rtbf.be/article/cop26-quand-des-oiseaux-ne-migrent-plus-jusqu-en-afrique-comme-si-levolution-se-passait-devant-nos-yeux-10869636 (consulted in January-March 2022).*

[66] *High confidence, see: IPCC. (2022). Summary for Policymakers [H.-O. Pörtner, D.C. Roberts, E.S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem (eds.)]. In: Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. In Press.*

[67] *High confidence, see: IPCC. (2022).*

[68] *High confidence, see: IPCC. (2022).*

[69] *High confidence, see: IPCC. (2022*

4.2.1 Climate action & biodiversity: minimizing trade-offs, maximizing co-benefits

When looking at the interactions between steps to address climate change and biodiversity erosion, two concepts are essential and should serve as a framework of analysis:

Co-benefits designate the actions that promote climate change mitigation as well as the preservation of biodiversity.

Example: preserving the Amazon forest is beneficial to both climate and to the rich biodiversity that has evolved with this habitat over the past millenaries.

Trade-offs designate the actions that benefit one of the two, but are detrimental to the other.

As the think-tank IDDRI[70] underlines **"the existence of trade-offs between climate and biodiversity and the importance of attenuating them remains often a major blind spot in international discussions".**[71] Biodiversity benefits gained from mitigating climate change are often well understood. There is a clear consensus that a disrupted climate negatively impacts habitats and species, such as a high frequency of extreme events like 'megafires'. As a result co-benefits are often brought forward with scarcely any attention paid to the existence of potential trade-offs.

Thankfully, the tide is starting to turn. A good example of commitment going in the right direction regarding the maximization of climate-biodiversity co-benefits is the one taken at the One Planet Summit by France and a coalition composed of Canada, the United Kingdom and Norway. In that sense, France committed to allocate 30% of its bilateral climate funding directly to biodiversity by 2030, while the United Kingdom committed to allocate £3 billion to projects with co-benefits for biodiversity.

"To achieve these goals, Protected Areas need to be developped both in terms of quantity of protected land area and in terms of quality of protection"

Source: Authors based on IPCC. (2022)

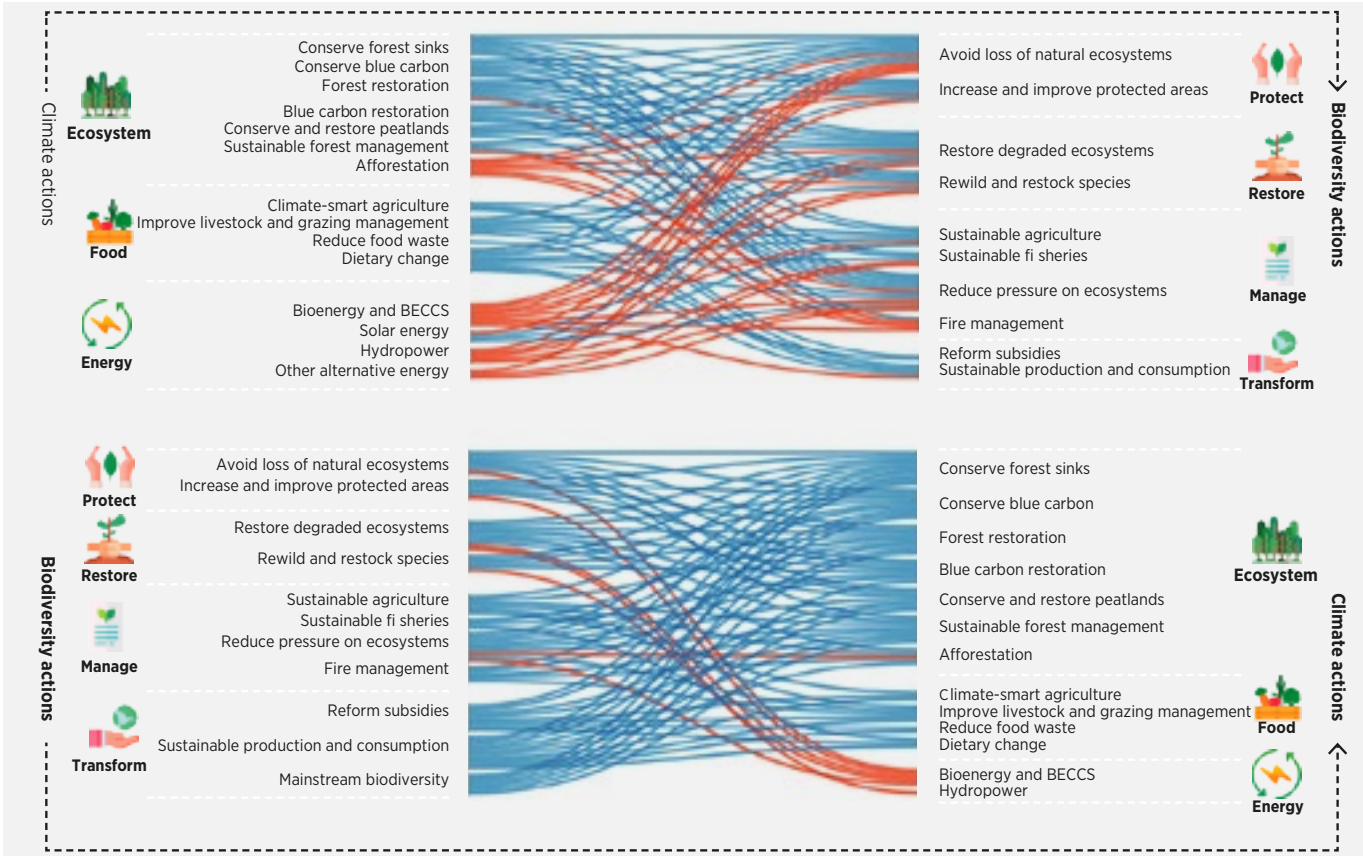
[70] *Institut du Développement Durable et des Relations Internationales.*

[71] *Deprez, A. et al. (2021). Aligning high climate and biodiversity ambitions in 2021 and beyond: why, what, and how? IDDRI, Study N°05/21.*

In its upper half, Figure 9 shows the effects of climate actions on biodiversity, and in the lower half the effects of biodiversity preservation actions on climate. Blue links symbolize positive impacts and red links negative impacts. There are two overarching conclusions here:

- Most of the links are blue, meaning that a majority of actions can be considered as co-benefits;
- There are more red links in the upper part than in the lower half, meaning that there is a higher risk of trade-offs when acting on climate change mitigation than when preserving biodiversity.

Figure 9. Impacts of climate actions on biodiversity, and of biodiversity actions on climate



Blue lines represent positive effects, orange lines negative effects.This network of interaction is evolving as many of the solutions are still in the ideation phase or have not yet been deployed at any sizable scale. Likewise, the strength of interactions may shift over time as the scale of solutions moves beyond the threshold at which unforeseen interactions, positive or negative, may occur.

Source: IPBES Secretariat. (2021), Launch of IPBES-IPCC co-sponsored workshop report on Biodiversity and Climate Change. [Video]. YouTube. https://www.youtube.com/watch?v=pJZx_hYJgdQ

4.2.2. Trade-offs examples: Bioenergy, textile and carbon offsets

The magnitude of climate-biodiversity trade-offs is significant. Oftentimes, the tension that underpins trade-offs lies in the incremental need for land to replace fossil resources consumption.

Three topics have caught our attention and will serve as examples of trade-offs in our analysis:

- **Bioenergy:** It emphasizes the challenges associated with switching from a system based on fossil resources to one based on renewable resources like crops;
- **Biosourced raw materials:** The textile industry exemplifies the challenges associated with switching from fiber production based on fossil resources to renewables like cotton, leather, linen, etc;
- **Carbon offsets:** Illustrate the opportunities associated with integrating climate and biodiversity in a common approach, and the cost of not doing so.

"Co-benefits are often brought forward with scarcely any attention paid to the existence of potential trade-offs."

Source: Authors, based on Deprez, A. *et al.* (2021)

TRADE-OFF 1: BIOENERGY WITH CARBON CAPTURE AND STORAGE (BECCS)

"BECCS" is defined by the IPCC as "Carbon dioxide capture and storage (CCS) technology applied to a bioenergy facility".[72] Bioenergy here designates all types of energies "derived from biomass or its metabolic by-products"[73] such as wood biomass, ethanol fuel, or bacterial decomposition. These methods all:

1. Draw CO_2 out of the atmosphere through photosynthesis[74] as the plants or trees grow;

2. Use carbon-capture technologies to store the CO_2 emitted when the biomass is burnt and converted into energy (electricity, gas or fuel).

The whole production process is expected to emit less than what was stored, therefore allowing a negative carbon balance throughout the operation.

BECCS appear today as the least expensive option for large scale carbon removals, and are widely mentioned in IPCC net-zero scenarios. A net-zero scenario is achieved when carbon emissions are fully compensated by removals of excess carbon from the atmosphere. The lower the reduction of carbon emissions between 2020 to 2050, the higher the need for carbon storage techniques such as BECCS to limit climate change to manageable levels (ideally +1,5°C according to the Paris Agreement). In the +1,5C° scenarios where the world does not manage to cut GHG emissions by half by 2030, large-scale BECCS should be used to remove part of that excess carbon dioxide from the atmosphere.

[72] *IPCC (2018). Annex I: Glossary [Matthews, J.B.R. (ed.)]. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.*

[73] *IPCC (2018). Annex I: Glossary [Matthews, J.B.R. (ed.)].*

[74] *"the process by which green plants and some other organisms use sunlight to synthesize nutrients from carbon dioxide and water" Oxford Dictionnary.*

On top of the technical limits of these BECCS (still under development), trade-offs with biodiversity occur with large scale use of BECCS as their needs for agricultural & forestry land compete with natural areas.

Most deforestation and land conversion occur as global demand for natural resources keeps rising. Switching from fossil energy stored in high density underground, to agriculture-based energy produced with a lower density aboveground requires additional agricultural space. In addition, commodities used to produce bioenergies are usually grown in conventional monocultures (rapeseed, maize, etc.), which contribute to increasing drivers of biodiversity loss.

In fact, **"future bioenergy expansion is largely projected to be grown in monocultures[75, 76], while "half of ideal bioenergy growing areas are situated in biodiversity hot-spots".[77, 78]**

How we reach the Paris Agreement is just as important for biodiversity as reaching it. IDDRI compared two different net-zero pathways: one where global emissions are cut dramatically from now on, and the other where greenhouse gasses emissions peak later and at a lower speed. In the latter scenario, significantly more excess carbon dioxide needs to be removed from the atmosphere, therefore requiring an area the size of Australia of agricultural land allocated to BECCS.[79]

This raises the question of food security and how farmers would be asked to feed 9 billion people as well as cars, trucks and industrial plants. All the more as protected areas are expanding.

TRADE OFF 2: RAW MATERIALS

In order to reduce their reliance on fossil fuels, more and more companies are switching away from fossil-based raw materials. In particular, the textile industry is heavily reliant on synthetics materials (mainly polyester), which compose more than half of the materials used in volumes (Figure 10).

With respect to biodiversity, a net-zero fashion industry cannot conserve the same production logic while switching to natural fibers. A carbon net-zero world would require drastically reducing reliance on fossil-based materials. However, considering the expected rise in fiber volumes due to the high turnover of clothing collections (+34% volumes in 2030 compared to 2020), such reduction would rely on a very significant increase in agricultural land dedicated to fiber production such as cotton, wool or others.

As with bioenergy, this increase would encroach on key biodiversity areas, and compete with food production.

Positive signs can be noted, with Kering launching a Regenerative Fund for Nature investing in protection and restoration of natural habitats, while improving practices, by adopting regenerative agriculture. Coupled with a reflection on volumes and reducing dispensable demand, these initiatives could build the logic of a desirable textile sector. The particular case for circular economy in the textile sector is detailed in Part 2.

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[75] *Deprez, A. et al. (2021). Aligning high climate and biodiversity ambitions in 2021 and beyond: why, what, and how? IDDRI, Study N°05/21.*

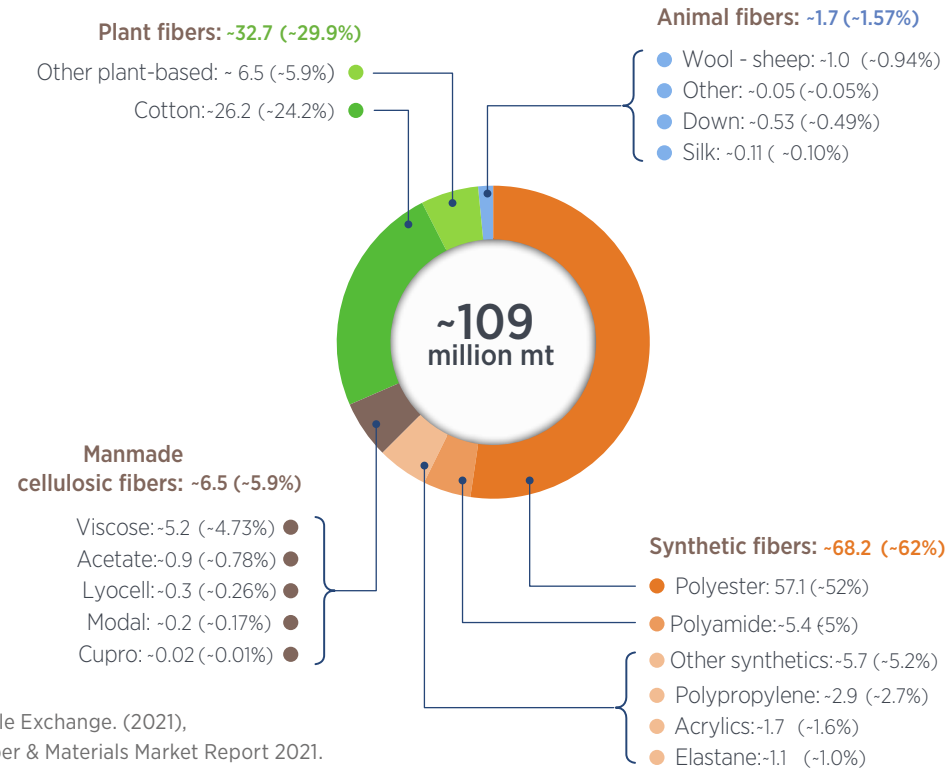
[76] *IPBES (2019), Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages.*

[77] *Deprez, A. et al. (2021).*

[78] *Santangeli, A., Toivonen, T., Pouzols, F. M., Pogson, M., Hastings, A., Smith, P., & Moilanen, A. (2016). Global change synergies and trade-offs between renewable energy and biodiversity. Gcb Bioenergy, 8(5), 941-951.*

[79] *Deprez, A. et al. (2021).*

Figure 10. Global Fiber Production in 2020



Source: Textile Exchange. (2021),
Preferred Fiber & Materials Market Report 2021.

TRADE OFF 3: CARBON OFFSETS AND TREE PLANTATION

Carbon offsets and credits could include biodiversity criterias. Large-scale tree planting can be detrimental to biodiversity or inefficient for climate if not done properly.

Two types of tree planting can be distinguished:

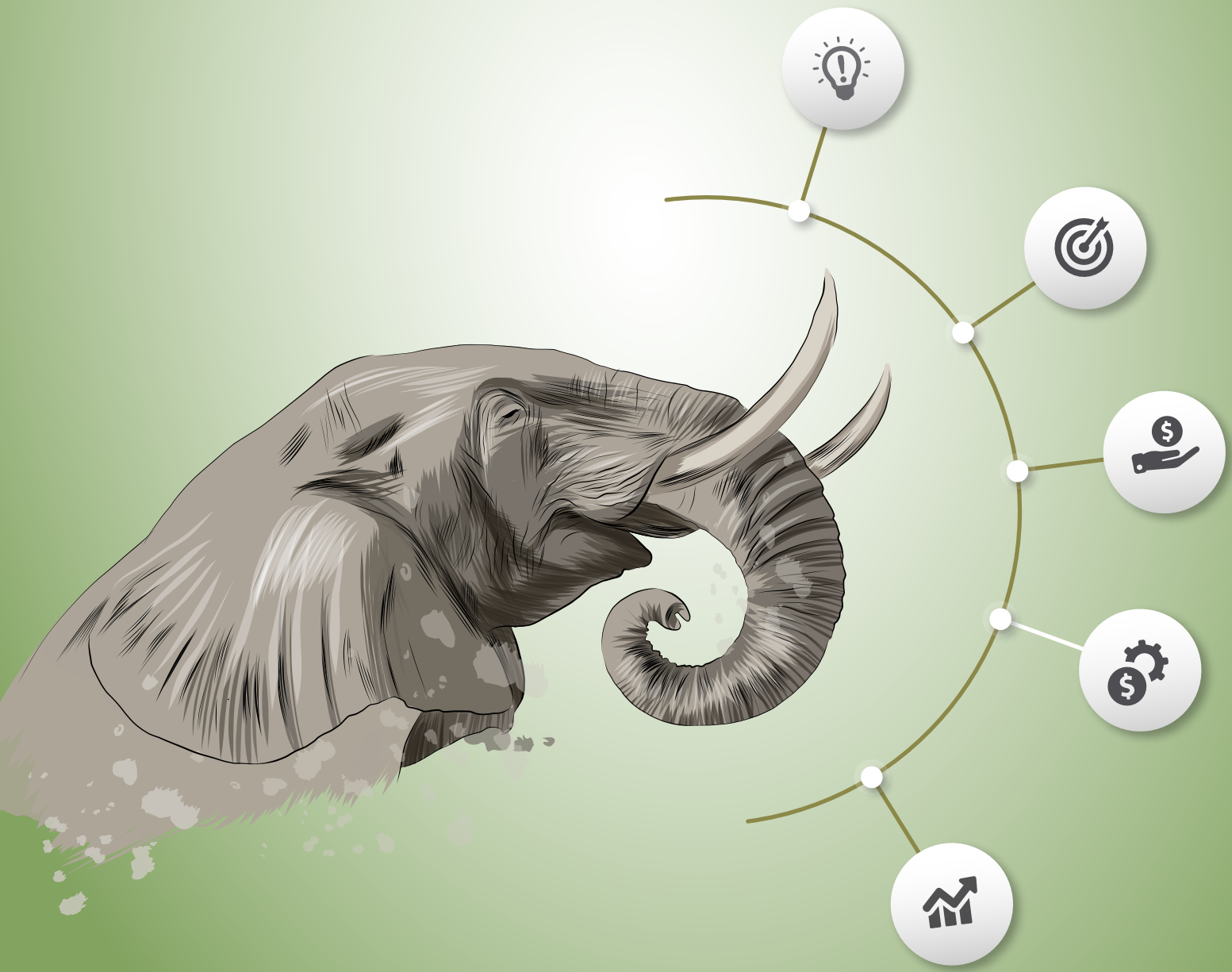
1. Afforestation, *i.e.* planting trees in areas that had no previous tree cover, **has impacts on biodiversity that may range from positive to negative**. "While afforestation of desertified or degraded land may likely have positive impacts on biodiversity, widespread afforestation, especially of grassy biomes with few trees such as savannas, would be highly detrimental to biodiversity".[80]

2. Reforestation which occurs in areas that had previously been covered with trees, **can be inefficient for both biodiversity and climate change mitigation if not done properly**. Natural regeneration should be preferred to single-species plantations as it is not only better for biodiversity but has greater carbon sequestration performance. "For example, if the 3.5 million km² of degraded land committed by countries in the Bonn Challenge are reforested through natural regeneration, they would capture 42 Gt of carbon through 2100; if reforested through plantations, they would capture only 1 Gt in the same period".[81] Moreover, **biodiverse ecosystems are more resilient than monocultures, therefore decreasing the risks of carbon leaks.**

[80] *Deprez, A., Vallejo, L., & Rankovic, A. (2019). Towards a climate change ambition that (better) integrates biodiversity and land use. IDDRI study n°8 November 2019. based on Lewis, S. L., Wheeler, C. E., Mitchard, E. T., & Koch, A. (2019). Regenerate natural forests to store carbon. Nature, 568(7750), 25-28.*

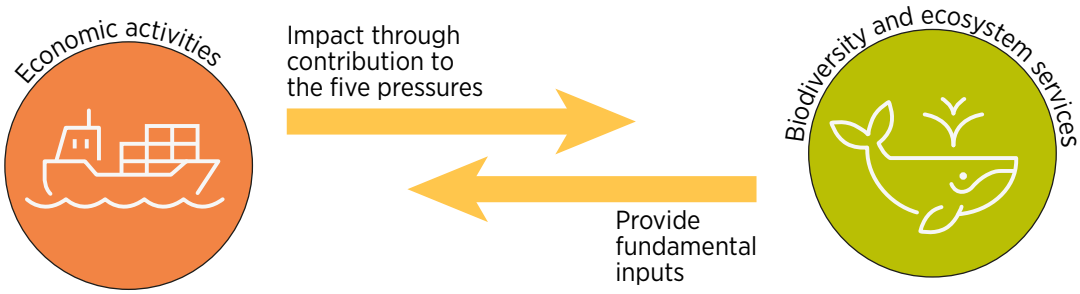
[81] *Ibid.*

B. *Links between biodiversity and businesses*



Most companies today do not consider biodiversity among their top priorities. They are not yet aware of the impact of biodiversity loss on their bottom lines. Nevertheless, companies are significantly dependent on biodiversity and natural capital, and this creates several risks and opportunities, more or less significant according to the sectors and types of actors. What are these links?

Biodiversity is linked with business in two ways as economic activities are dependent on ecosystem services and as they impact biodiversity in contributing to the most important pressures on it. This is what we call the double materiality, as illustrated below.



1. ALL INDUSTRIES ARE IMPACTING NATURE, WHEN ADOPTING A VALUE CHAIN APPROACH

Companies have a significant and well-documented negative impact on biodiversity. Generally speaking, human activities are assessed to have caused the destruction of 44% of the world's biodiversity.[82,83] Yet, humanity would need at least 72% of the world's biodiversity preserved to remain within the safe operating space of Earth (planetary boundaries concept).

The sectors contributing to pressures on biodiversity are presented in table 2 above and table 3 below. Please note that the financial sector (banking, insurance, investment industry) is not appearing *'per se'*, because it is a transversal sector.

While all sectors have an impact on biodiversity, direct resources exploitation industries have the most direct and immediate one, notably fishing, forestry and timber industry, mining industries, drilling and quarrying activities, agriculture and food industry, tourism, housing, etc.[84] As an example, the study of the impacts of European food consumption over the entire life cycle of food products (i.e. from cradle-to-grave) reveals that beef, pork and poultry meat consumptions altogether (and their value chain) are responsible for more than 50% of the total impact of food consumption on biodiversity in Europe. Land use, land use change and climate change are the three major sources of impacts on biodiversity in the European Union.[85]

[82] *Schipper A.M., Hilbers J.P., Meijer J.R., Antão L.H., Benítez-López A., de Jonge M.M.J., Leemans L.H., Scheper E., Alkemade R., Doelman J.C., Mylius S., Stehfest E., van Vuuren D.P., van Zeist W.-J. (2020). Projecting terrestrial biodiversity intactness with GLOBIO 4. Global Change Biology, 26(2), pp. 760-771.*

[83] *Lucas, P. and Wilting, H. (2018), Towards a Safe Operating Space for the Netherlands: Using planetary boundaries to support national implementation of environment-related SDGs. PBL Netherlands Environmental Assessment Agency, The Hague.*

[84] *Sainteny, G., Salles, J. M., Ducos, G., Marcus, V., Duboucher, P., Paul, E., ... & Pujol, J. L. (2012). Les aides publiques dommageables à la biodiversité. Documentation française.*

[85] *Crenna, E., Sinkko, T., et Sala, S. (2019), Biodiversity Impacts Due to Food Consumption in Europe, Journal of Cleaner Production 227: 378-91.*

When studying a specific activity, impacts on biodiversity may be either direct (at the site level) or indirect, mostly through upstream value chain activities. Direct impacts at site level are particularly significant when sites are located next to or in biodiversity hotspots: habitat destruction or introduction of pollution in the ecosystem. Indirect impacts can be as significant, and stem from the consumption of highly impactful products (through imported deforestation products for instance).

Understanding the impact of businesses on biodiversity requires a value-chain and sectoral approach. In order to be able to carry out an assessment and come up with potential solutions, a clear understanding of the biodiversity impact of each component of a value chain is required.

For sectors other than those related to direct resources exploitation, the most significant share of the biodiversity footprint often lies at the beginning of the value-chain. This is notably the case for several services companies, for which the main impact is via inputs. In addition, the identification of biodiversity impacts and potential best practices requires a sectoral approach: obviously because value chains differ, but also because the type of impacts on biodiversity vary significantly from one sector to the other. Land use is the main pressure on biodiversity for the food industry (driving 70% of the impact)[86], whereas pollution is probably the most important pressure for the chemical industry.

2. ALL INDUSTRIES DEPEND ON NATURE, MORE OR LESS SIGNIFICANTLY

Like human life, economic activities depend directly or indirectly on biodiversity and ecosystem services: more than 50% of the world's economic creation of value is strongly dependent on nature. Most companies do not acknowledge their reliance (only seven CAC40 companies investigate their nature dependency[87]). When they do, they mostly concede their tie with provisioning services.[88] Yet, all activities hinge at the very least on regulating services and supporting services, and some on cultural services as well.

"The four most contributing sectors to climate change are: industry (29%), transport (16%), energy use in buildings (18%) and agriculture, forestry (18%)."

Source: Ritchie, H and Roser, M. (2020)

[86] *Crenna, E., Sinkko, T., et Sala, S. (2019), Biodiversity Impacts Due to Food Consumption in Europe, Journal of Cleaner Production 227: 378-91.*

[87] *Boucherand, S., Bouquet, C., Le Gal, A., Deda, A., Nogueira, M., Terraube, L. (2015), Analyse comparée des politiques et des actions déclarées en faveur de la biodiversité et des services écosystémiques par les entreprises du CAC 40., Paris: B&L Evolution.*

[88] *See part I.A. Nature provides food, wood, fresh water, biochemical and genetic resources (key for instance in medicine but not only), energy resources, and other raw materials, as the result of the interaction of living organisms in their ecosystems.*

Table 3. Major sectors directly or indirectly linked to nature issues

Value chains	Sectors concerned	Level of dependency of value chains	Most significant dependencies on ecosystem services	Level of impacts of value chains	Most significant impacts*
Agrifood	•Food, beverage and tobacco manufacturing •Fishing and aquaculture •Crop and animal production, hunting and related services	Very High	•Pollination, soils, photosynthesis	Very High	•Use of land, pollutants (pesticides, fertilisers)
Chemicals and pharmaceuticals	•Chemical industry •Pharmaceutical industry	Medium	•Biosourced molecules, inspiration	Medium	•Release of pollutants, incl. persistent organic pollutants, endocrine disruptors and metal compounds (*e.g.* lead, mercury)
Energy	•Production and distribution of electricity, gas, steam and air conditioning •Oil and gas extraction and support services for extractive industries	High	•Use of wind, solar, water flows •Use of natural capital resources (fossil and biofuels)	Very high	•Destruction of natural habitats for resources extraction, usually located in key biodiversity areas (terrestrial and marine) •Diverse pollutions
Water and sanitation	•Water collection, treatment and distribution	Medium	•Phyto-treatments Use of communities of micro-organisms for all wastewater treatments	Low	•Release of potentially still polluted waters
Extractive industries	•Mining of metal ores •Oil and gas extraction and supporting services for the extractive industries	Medium	•Long term biogeochemical cycles (carbon) Stable climatic conditions	Very high	•Destruction of natural habitats for resources extraction, use of highly polluting techniques

Real estate industry including accommodation and tourism	•Building construction and specialised construction work •Accommodation and tourism •Rental and operation of owned or leased real estate •Civil engineering	Medium	•Bio-sourced construction raw materials •Iconic vegetation and wildlife	High	•Artificialization of soils and disruption of hydrological flows
Textile	•Textile, clothing, leather and footwear manufacturing •Crop and animal production, hunting and related services •Chemical industry	High	•Bio-sourced raw materials from plants (***e.g.*** cotton, flax) and animals (***e.g.*** leather, wool, cashmere)	High	•Land use change Degradation of agricultural lands through intensive practices •Over exploitation of natural resources (***e.g.*** the Aral Sea crisis caused by the irrigation of cotton fields) •Release of pollutants incl. fertilisers, metallic compounds, organic material
Transportation	•Land and pipeline transport, water transport, air transport, warehousing and auxiliary transport services	High	•Biofuels •Raw materials (***e.g.*** rubber in tires from hevea trees) •Stable climatic conditions (disruptions from extreme weather events)	Very high	Artificialization •Disruption of ecological discontinuities (transportation infrastructure) •Release of pollutants (oil spills)
Wood chain	•Forestry and logging •Woodworking, paper and cardboard industry, furniture manufacturing	Very high	•Raw materials •Regulation of natural cycles (water, nitrogen, climate)	Medium	•Destruction of primary forests •Degradation of forest soils by machinery •Reduced tree diversity •Introduction of exotic invasive species (***e.g.*** Black locust tree in Europe)

Table 3:

*__Most significant impacts:__ Without detailing much the climate change contribution of these sectors. For information, the 5 most contributing sectors to climate change (in absolute CO_2 eq emissions) are: industry (29% of the world GHG emissions), transport (16%), energy use in buildings (18%), and agriculture, forestry (18%).[89]

Method: Data on dependencies and impacts have been collected from various sources and aggregated to get this synthetic view. Sources: see footnote.[90]

Biodiversity is not yet recognised as a major issue by most companies, even when they significantly rely on, or impact it, even by the most reliant or impactful. Companies' non financial reporting documents should reveal the entity's awareness of biodiversity issues. Firms directly concerned by biodiversity risks could be more prone to report on the issue.[91] The most impactful industries are exposed to reputational risk if they do not start reporting on biodiversity-related issues[92] .

6.1. This materialises in several risks, which can be turned into opportunities

Business activities are subject to several risks through impacts on nature and dependencies from ecosystem services, more or less severe or direct according to the type of industry. In addition to transition or physical shocks (following the same definitions as for climate risks, enlarged to natural assets), micro-and macroeconomic impacts materialise through changes in productivity due to natural hazards through government revenues, inflation, etc. As long as industries are concerned, risks can be classified as the following on Figure 11.

.

> **"All companies have an impact on nature, more or less significant depending on their sector and position in the value chain"**
>
> **Henri de Castries**, Chairman of Institut Montaigne

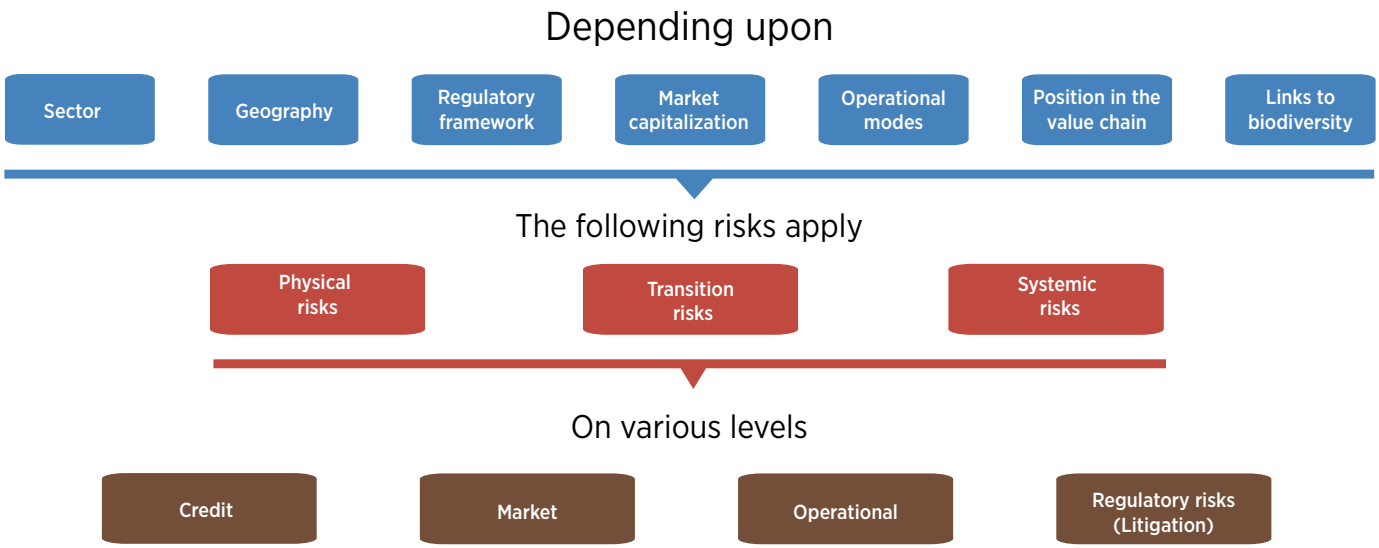
[89] Ritchie, H. and Roser, M. (2020) - «CO_2 and Greenhouse Gas Emissions». Published online at OurWorldInData.org. Retrieved from: https://ourworldindata.org/emissions-by-sector.

[90] FFA (2021), Assurance et biodiversité : enjeux et perspectives. -PRI. (2020), Investor Action on Biodiversity: Discussion Paper. -WEF and PwC. (2020), Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy,, New Nature Economy series. -IPBES (2019), Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages. -UN Environment Programme, UNEP Finance Initiative and Global Canopy. (2020)., Beyond 'Business As Usual': Biodiversity Targets and Finance. Managing Biodiversity Risks across Business Sectors. », UNEP-WCMC, Cambridge, UK, 42pp..

[91] Husin, N. M., Alrazi, B., Remali, A. M., & Jalil, A. (2018). Legitimizing Corporate Behaviour through Biodiversity Reporting: A Case of Malaysian Companies. Global Business & Management Research, 10(3).

[92] Husin, N. M., Alrazi, B., Remali, A. M., & Jalil, A. (2018). Legitimizing Corporate Behaviour through Biodiversity Reporting: A Case of Malaysian Companies. Global Business & Management Research, 10(3). and Smith, T., Paavola, J., & Holmes, G. (2019). Corporate reporting and conservation realities: Understanding differences in what businesses say and do regarding biodiversity. Environmental Policy and Governance, 29(1), 3-13.

Figure 11. The different types of business risks linked to biodiversity erosion



Source: Authors' creation

Procter & Gamble's shareholders voted a resolution (against the boards' recommendation) requiring the company to issue a report *"assessing if and how it could increase the scale, pace, and rigour of its efforts to eliminate deforestation and the degradation of intact forests in its supply chains"*. This pushed the executives of the company further on halting deforestation, and is thus an interesting example of how biodiversity and natural capital are key subjects to address for all companies. Reputational risks can be significant, notably for larger and listed companies.

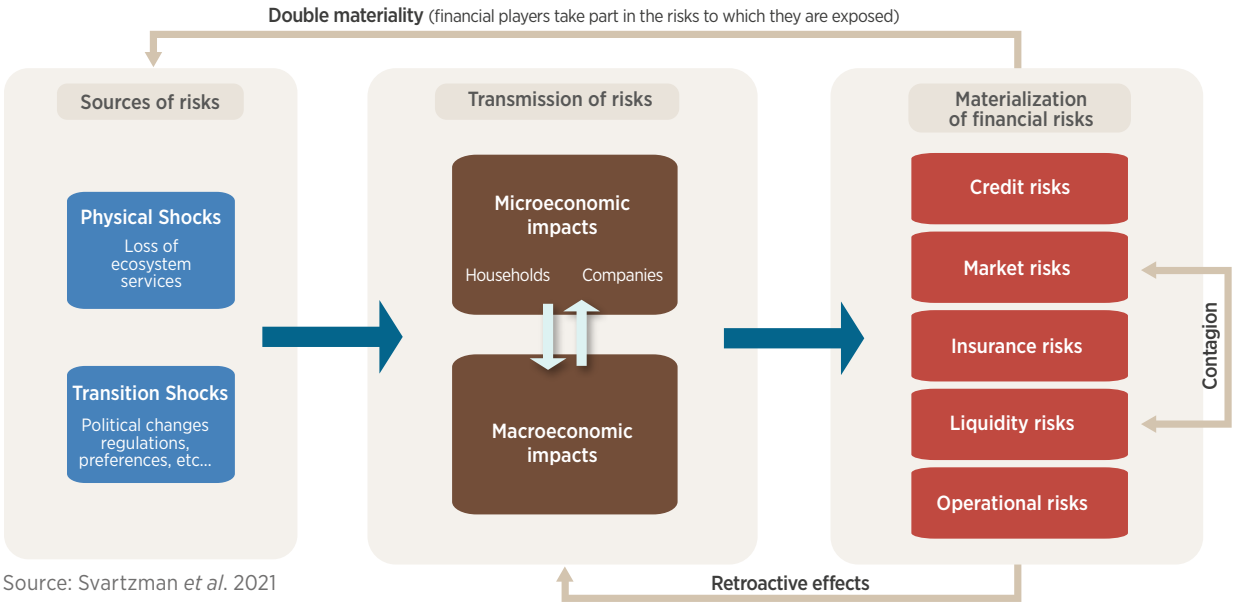
The financial consequences of these shocks can be material: increased risks of default and difficulty to access credit, repricing of assets and market risks, increased insured losses and insurance gap (underwriting risk), shortages of liquid assets (liquidity risk), disruption of supply chains and shortages of raw or processed materials (operational risks), etc. The consequences of physical and transition shocks are manyfold, and can lead to financial risks through both macro and micro economic impacts[93](Figure 12).

"Agro-chemical companies face very high transition risks that can be addressed through a deep transition to regenerative agriculture"

Sébastien Treyer, Executive Director, IDDRI

[93] *Svartzman, R., Espagne, E., Julien, G., Paul, H. L., Mathilde, S., Allen, T., ... & Vallier, A. (2021). A'Silent Spring'for the Financial System? Exploring Biodiversity-Related Financial Risks in France. Banque de France Working Paper No. 826.*

Figure 12. Macro and micro economic impacts



Source: Svartzman *et al.* 2021

TRANSITION RISKS - EXAMPLE

Transition risks materialise through regulatory or market pressures linked to the integration of environmental concerns in operations of companies. As such they "relate to [a] process of adjustment"[94] towards a nature-positive economy. For example, anti-deforestation legislation increases due diligence costs for buyers of soft commodities that could be connected to deforestation.

PHYSICAL RISKS - EXAMPLE

Physical risks arise when natural systems are compromised, due to the impact of climatic (i.e. extremes of weather) or geological (*i.e.* seismic) events or widespread changes in ecosystem balance, such as soil quality or marine ecology.[95] They correspond to a more or less rapid decrease in the quality of ecosystem services. They can arise occasionally or be more longer term. If pollinators were to disappear completely, replacing their service with artificial pollination techniques would cost EUR153 billion per year (or 9.5% of the world's agricultural production - EU, 2008).

SYSTEMIC RISKS - EXAMPLE

Systemic risks correspond to effects occurring after a first order risk (that can be physical or transition risks).

[94] *Network for Greening the Financial System. (2020), Overview of Environmental Risk Analysis by Financial Institutions.*

[95] *University of Cambridge Institute for Sustainability Leadership (CISL, 2021). Handbook for nature-related financial risks: key concepts and a framework for identification.*

Box 3

The loss of biodiversity: a driver of pandemics

The Ebola crisis (11 310 deaths and an estimated economic impact of USD53 billion), the Zika outbreak in 2017 (3000 to 9000 babies affected by microcephaly, a major physical deformity), and the ongoing Covid-19 crisis (5,88 million deaths, estimated cost of EUR1 trillion for France alone[a]) are all linked to the loss of biodiversity.

The five main drivers of biodiversity loss (land use change, resource exploitation, climate change, pollution, the introduction of exotic invasive species) **are also increasing the risk of global pandemics** (see IPBES, 2020[b]). 70% of emerging diseases, including Zika, Ebola and Covid-19 are caused by microbes of animal origin or zoonoses.

The emergence of a disease depends on:

(1) the human interactions with species that host harmful microbes

(2) the transmission dynamics among human populations.

Human encroachment in all environments and rising demographics are increasing the number of interactions between humans and potential pathogens, rapidly rising the risks of pandemics. The concentration of people in megacities, the increasing rural-urban and globalised tradelinks then stimulate the transmission of pathogens among human populations at a global scale. Epidemics that would previously have been limited to rural communities are therefore now more likely to generate worldwide pandemics.

According to IPBES, humanity has entered in a pandemic era. Covid-19 like pandemics will become more and more frequent with the potential for major socio-economic disruptions. "Pandemics and other emerging zoonoses" already "cause [...] likely more than a trillion dollars in economic damages annually" (IPBES, 2020, p.3). These economic costs include short term costs (treatment costs, quarantines, travel restrictions, disruption of global supply chains) and long term costs (permanent disabilities, losses of opportunities...). The United Nations calls for a "One Health" approach that tackles human, animal and environmental issues jointly to mitigate these joint systemic risks.

a) Source: Published by M. Szmigiera. (2022), Impact of the coronavirus pandemic on the global economy - Statistics & Facts, Statista.com, https://www.statista.com/topics/6139/covid-19-impact-on-the-global-economy/#dossierKeyFigures
RFI (2021), Covid-19 to cost France nearly half a trillion euros over three years, retrieved from: https://www.rfi.fr/en/france/20210414-covid-19-to-cost-france-%E2%82%AC424billion-over-three-years (consulted in January-March 2022).

b) Source: IPBES (2020) Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services. Daszak, P., Amuasi, J., das Neves, C. G., Hayman, D., Kuiken, T., Roche, B., Zambrana-Torrelio, C., Buss, P., Dundarova, H., Feferholtz, Y., Földvári, G., Igbinosa, E., Junglen, S., Liu, Q., Suzan, G., Uhart, M., Wannous, C., Woolaston, K., Mosig Reidl, P., O'Brien, K., Pascual, U., Stoett, P., Li, H., Ngo, H. T., IPBES secretariat, Bonn, Germany, DOI:10.5281/zenodo.4147317

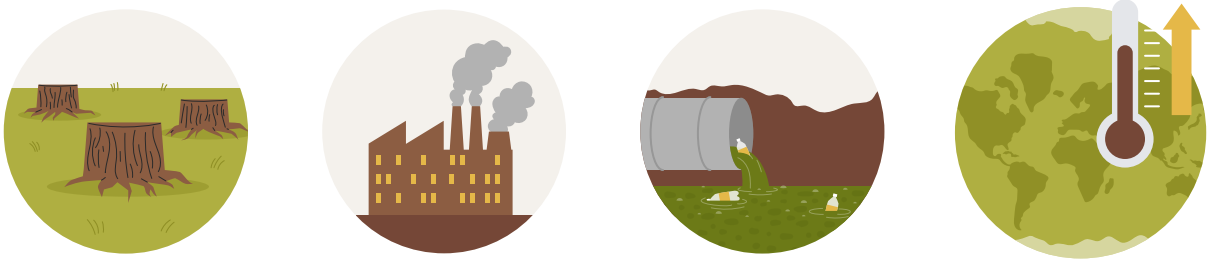
As for every situation, these risks can also reveal opportunities to act and live the 'transformational change' described by the IPBES. **Indeed, new ways of doing are to be created, and this includes inventing new business models. The reflection must be led on how to maintain or even increase our livelihoods without destroying nature at this alarming pace.** The issue deals both with alleviating current drivers of biodiversity loss and restoring biodiversity.

Transforming operations to implement best practices, sourcing raw materials that ensure environmental quality, and fighting against overconsumption, waste pollution, and other downstream noxious impacts are first steps that are accessible for companies - and allow them to anticipate regulatory and societal changes. Such actions can be led if there is knowledge within the company about the main impacts to be addressed.

In addition, new activities and processes should be invented (or re-invented). Deep-tech and low-tech innovation processes are both required. They are enablers and their inputs for the required 'transformative change' are detailed in part II.

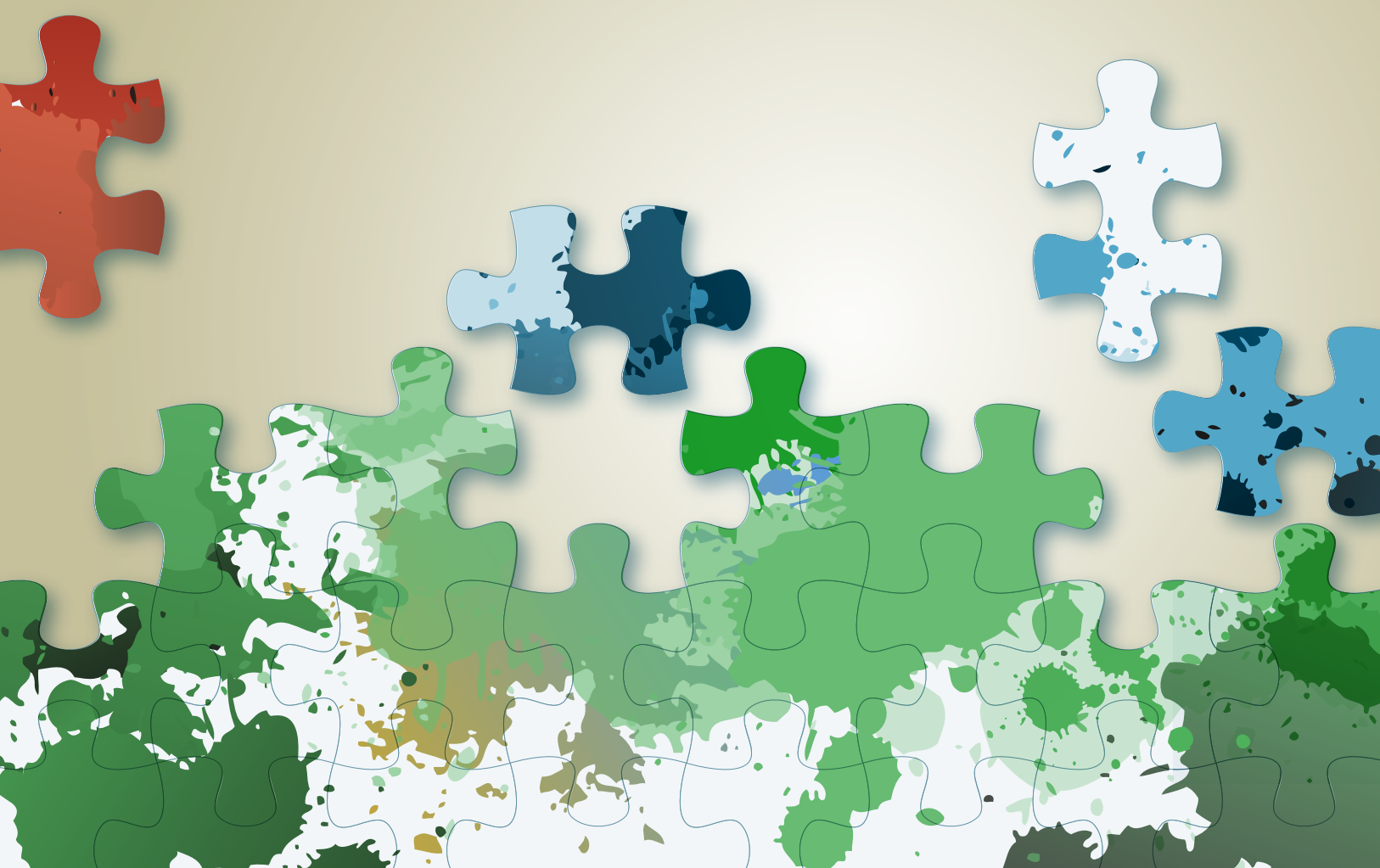
"The five main drivers of biodiversity loss (land use change, resource exploitation, climate change, pollution, the introduction of exotic invasive species) are also increasing the risk of global pandemics."

Source: Authors, based on IPBES, 2020



PART II

Beyond the facts: taking action



1. PREAMBLE

Part I of this report aimed at presenting the scientific evidence of the biodiversity crisis, and the links between biodiversity and economic activities. Notably, it establishes why biodiversity was a critical business concern, because economic activities are a major driver in the loss of biodiversity, and as a significant part of the economy depends on the services provided by natural ecosystems and organisms.

Part II is notably based on more than 50 interviews with non-governmental organisations, scientists, business and finance leaders. These interviews complement the review of reports and data publicly available, which served as a basis for this report. Through these encounters with experts and decision makers, we were able to better assess the level of awareness of biodiversity issues which prevails in the business community, as well as the challenges encountered. Several ideas and best practices came up, some of which are presented herein.

Part II is action-oriented: we therefore present some interesting initiatives, difficulties raised by experts and business leaders, as well as proposals to better take biodiversity into account in business, consumer, and policy decisions.

2. RAISING AWARENESS AND BRINGING ALL STAKEHOLDERS ONBOARD

2.1 Awareness is rising, yet lags behind climate change

Awareness of biodiversity is on the rise but remains well below that related to climate change. Biodiversity is a multifaceted issue. The loss of life is tangible and materialises in every aspect of our daily lives, yet surprisingly, people fail to grasp their breadth as opposed to CO_2 emissions which are invisible.

"Significant biodiversity upskilling is needed in the private sector. This is the precondition for corporates to move away from just being aware of biodiversity loss, and start addressing this crisis from a strategic perspective".

Robert-Alexandre Poujade,
Biodiversity Lead, BNP Paribas Asset Management]

Until recently, biodiversity discussions had often been focusing on what is known as "flagship species", *e.g.* pandas or elephants, the protection of which is important, yet represents only a part ofview of the biodiversity challenges we are facing. While the identification of endangered flagship species is important to create awareness of the degradation of biodiversity, it can overlook:

- The accelerated disappearance of less visible species, a typical example being soil biodiversity;
- The decrease of the number of animals or plants across species, even when the species are not per se endangered;
- The decrease in the numerous services provided by these species, such as pollination by insects.

There is now more widespread recognition of the critical importance of 'ordinary biodiversity', and that all living organisms should be looked after and conserved.

Looking at climate change, we are in a position to better understand how awareness builds up: several decades were needed to convey the message to the general public, and important shortfalls persist despite an overwhelming academic consensus and the production of an abundant literature presenting in detail the hard evidence behind climate change, its drivers and its impact on our everyday lives.

The prevalence of climate change in public environmental debate could partly hinder the rise of biodiversity loss as a key area of focus. It is critical to convey the message that the climate and biodiversity crises are two faces of the same coin. This is even more necessary considering the importance of spillovers between climate change and biodiversity (*e.g.* climate change impacts biodiversity, and fostering biodiversity is key to solving the climate crisis). The required transformation to respond to these challenges corresponds to a redesign of the relationship to nature of modern civilisations.

The gains made in raising awareness about climate change can also be seized as an opportunity to do the same with biodiversity, notably by focusing on risks at the intersection of these two issues, such as losing ecosystems storing carbon.

Several experts indicated that significant time was lost on the issue of climate change because of doubts over its existence. This problem should not be overlooked when it comes to biodiversity, especially as there is a similar - and possibly higher - urgency in tackling the loss of biodiversity as there is with climate change. All the more so since the biodiversity planetary boundary has been crossed and believed to be further into the high-risk zone.[96]

To convey the need to tackle biodiversity, the choice of words is obviously important, and the reference to 'life preservation' and 'nature' can make the issue more concrete.

> **"The shift from "biodiversity" to "nature" in various initiatives gives the opportunity to have a broader and strategic approach and reach C-level executives."**
>
> **Claire Varret,**
> Senior Biodiversity Advisor, EDF

[96] *Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., ... & Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. Science, 347(6223), 1259855.*

In particular, the business community is showing a growing interest for biodiversity

Our discussions with business executives and experts clearly point out a fast growing awareness of biodiversity issues in economic spheres. It is part of a broader shift on the role of companies in tackling environmental and social issues, though biodiversity stands out as a structural component of the same magnitude as climate.

Companies can play a catalytic role in the preservation of biodiversity, alongside other stakeholders, leveraging on some of their distinctive features:

- **A long-term perspective=** notably when their shareholding and leadership structure are stable;
- **Access to stable funding=** both in the form of equity and debt. The generation of profits allows to support long-term investments, including those with environmental benefits. Non-governmental organisations (NGOs), and civil society as a whole, have relevant policy proposals and projects but they usually lack funding;
- **A close understanding of their value chain and impact on the environment=***.* This is particularly important in the field of biodiversity, in which impacts are diverse, more local and to a certain extent more difficult to assess from the outside - than in the case of climate change.

The rise in awareness is also driven by the interaction between corporates and investors, as illustrated by the broad support from institutional investors for a resolution at Procter & Gamble's 2020 annual meeting questioning the company's stance on palm oil and deforestation (see p.52).

However several experts pointed to the risk of a persistent gap between businesses' action plans and scientific knowledge. Therefore, considering the magnitude of the required transformations, **there needs to be strong awareness among C-level executives in order to engage the rest of companies' stakeholders, both internally across business units and externally, *e.g.* suppliers.**

Awareness among executives will be more easily raised if, at least initially, they approach biodiversity from economic and risk perspectives (see part I). This can be achieved through a better assessment of their company's exposure to biodiversity risks, including the direct impact biodiversity loss would have on their profitability in the short to the medium term.

Experts stressed that there is a strong need to develop business cases and business models deemed compatible with the conservation of biodiversity *and ambitious biodiversity objectives*. This would be an important argument to help business executives commit their companies to the transition, with a clear landing point in sight.

Additionally, we note that companies are demonstrating a growing interest in contributing to policy debates in international forums such as the biodiversity COP and the 2021 IUCN summit in Marseille. Their commitment in this view is made easier by the multiplication of business coalitions (*e.g.* One Planet Business for Biodiversity[97], Finance for Biodiversity Pledge[98], Business for Nature[99], Act for Nature, etc.) contributing to the summits and beyond, to mobilisation in favour of issues. This is sometimes considered as an important first step akin to the progress at the intergovernmental level.

[97] *https://op2b.org/*

[98] *https://www.financeforbiodiversity.org/*

[99] *https://www.businessfornature.org/*

2.2 Biodiversity restoration and conservation is an ethical, social and societal challenge

The accelerated loss of biodiversity questions our relationship to nature and living species.

Climate change is triggering a debate about our relationship to energy, consumption and mobility. Biodiversity, while raising similar questions with respect to food and frugality among others, goes further by questioning our relationship to nature and life in general. Faced with the loss of biodiversity, we are compelled to question our place among all living species and ecosystems.

The neolithic agricultural revolution has initiated a new era of domestication of nature, with the aim of ensuring food provision and safety. This has led to profound changes in[100]:

- Human activity, from a hunter-gatherer lifestyle to farming;
- The organisation of human communities, moving away from small, largely nomadic groups to larger, sedentary communities with increasing structure;
- Human diets, notably with an increase in cereal consumption;
- Ecosystem organisation, with fields developing at the expense of natural habitat;
- Selection of plant and animal species, as humans relied more on the growing of certain plants (*e.g.*, wheat) and domestication of certain animals (*e.g.*, chickens, lambs, horses, etc.)

These changes spanned thousands of years, and were accompanied by gradual evolutions in our tenets, notably embracing the convictions that:

- Humans have a legitimate right, and possibly a duty to, domesticate and organise nature ("as it were, master and possessor of nature"[101]);
- Natural resources are plentiful.

Such changes were accelerated by the industrial revolution and the XXth century, which saw the emergence of vast and affordable quantities of powerful energy, as well as the availability of technologies ensuring a massive increase in productivity, an ability to monitor agriculture, and ensure food safety and diversification.

The combination of energy and natural resource availability, efficiency gains in the agricultural and industrial sectors, and technological improvements, led to several gains for mankind: an easier access to food for an increasing part of the population, lower prices and higher diversification (for a fraction of humanity), and the development of non-agricultural activities (as food production became more efficient).

However, it is now clear that the depletion of natural resources is a threat to the environment and mankind, and that human activity - be it consumption, or the production of industrial and agricultural goods, and services - is a major contributor to this decline.

[100] *See the special chapter "Néolithique: L'agriculture a-t-elle fait le malheur des hommes?" in the journal L'Histoire n°492 (February 2022) and more specifically the following articles: Demoule, J.-P. (2022). Une révolution mondiale. L'Histoire n°492.; and: Perlès, C. (2022). La colonisation de l'Europe. L'Histoire n°492.*

[101] *Descartes, R. (1878). Discours de la méthode pour bien conduire sa raison et chercher la vérité dans les sciences.*

The profound transformation ahead of us raises several issues of an ethical, social and societal nature. While it is not the purpose of this report to discuss these issues, some of them are mentioned in order to illustrate the depth of the topics alluded to by biodiversity:

- Evolution of diets: To which extent are we able to change our diets in favour of a lightened animal protein intake?
- Price of food: Shall we reappraise the balance between, on the one hand the availability and price of food, against more environmentally friendly practices, on the other?
- Animal well-being: How do we address the well-being of animal species?

Debating these issues in a public forum can give birth - to a broader consensus on the choices to be made, since they determine certain structural economic and social balances.

KEY LEARNINGS

- The biodiversity challenge raises significant ethical, social, and societal issues, which can be discussed in the public arena;
- This discussion should notably highlight the trade-offs needed to effect a transition, at economical, geographical and social levels;
- Enlisting all stakeholders in this debate (consumers, companies, the farming community, regional and national governments, NGOs, etc.) is important to reach a broader consensus on the approach to be retained.

2.3 Awareness of the importance of biodiversity must be fostered in society as a whole

Given the economic, social, and societal issues at stake, awareness of biodiversity matters should be fostered for the general public, beyond experts, business leaders and policy makers. This would guarantee the involvement of all concerned stakeholders.

To maximise its impact, the biodiversity narrative could focus on "day-to-day" biodiversity - and not only on flagship species for instance - helping people realise the extent to which their lives rely heavily on diverse ecosystems. As was done with climate change, it can be particularly efficient to insist on the economic and health impacts of the biodiversity decline to increase awareness and action.

The 'why biodiversity matters to all' should also be made more explicit. Several examples can be used: the dependency of human health on biodiversity and ecosystems (see box 3 for more details), or the social benefits of functional ecosystems (many livelihoods depend on the stability of natural ecosystems, especially in lower income countries).

It is critical to link the climate and biodiversity challenges. Awareness about biodiversity can also benefit from similarities with the climate crisis, notably by conveying the message that both are equally existential threats and should be addressed as such.

2.4. Education and training on biodiversity matters is essential

The understanding of the main concepts underlying the biodiversity crisis remains on average limited - a trend reinforced by the breadth of issues at stake. This calls for a reappraisal of how biodiversity is included in education and training systems at all levels.

> **"ADEME has established 4 net-zero scenarii, and they all came to the same conclusion: protecting life and enhancing biodiversity is the first priority."**
>
> **Baptiste Perrissin Fabert,**
> Executive Director, Expertise and Programs, ADEME

Environmental issues, and biodiversity in particular, need to be included in curriculums from the earliest stages, i.e. primary and secondary education. If concepts should naturally be defined and mastered, field experimentations and in vivo experiences are particularly valuable and relevant when it comes to biodiversity and should be reinforced. Basic knowledge in mathematics and physics is of course also fundamental.

> **"To address biodiversity you need to be able to tackle complex systems. Training on complex living systems needs to be reinforced in all curriculums."**
>
> **Dr & Phd Hélène Leriche,**
> Veterinarian and Doctor in Ecology

KEY LEARNINGS

- In order to raise awareness of the biodiversity challenge, a focus on 'ordinary' biodiversity and daily life examples would be advisable;
- The interconnexions between biodiversity and health (***e.g.***, zoonoses, drug innovation) are particularly pertinent;
- So is lower-income countries' dependence on biodiversity for livelihoods;
- The link between the climate and biodiversity risks should also be stressed.

Higher education should aim at two complementary objectives when it comes to environmental education:

- On the one hand, ensure that students entering the labour market have at least a basic understanding of nature, the extent of the biodiversity crisis and its main drivers;
- On the other hand, train experts to design the technical and policy responses which will be needed to address the crisis.

On the first point for higher education, work needs to be done to create and integrate in current curriculums courses an interdisciplinary, non-technical introduction to biodiversity, its importance, the drivers of biodiversity erosion and the impact of its collapse on human ecosystems. Concretely, this can take the form of seminars with presentations from experts with various backgrounds, *e.g.* scientists, business and NGO executives, to present the main facts and Figures around the twin climate and biodiversity crises, as together they cover holistically environmental issues (*e.g.*, water

quality, pollution, social impact of environmental degradations, etc.).

As regards the training of biodiversity experts, specific curriculums might need to be designed to equip students with technical tools to develop the new type of innovations required to protect and restore biodiversity, while focusing on interactions between human and surrounding ecosystems. Education integrating a high-level of understanding about environmental issues in parallel with additional fields (finance, marketing, medicine, etc.) should be particularly favoured.

The largest and most reknown high education institutions should take part in this effort and integrate environmental and biodiversity matters in curriculums.

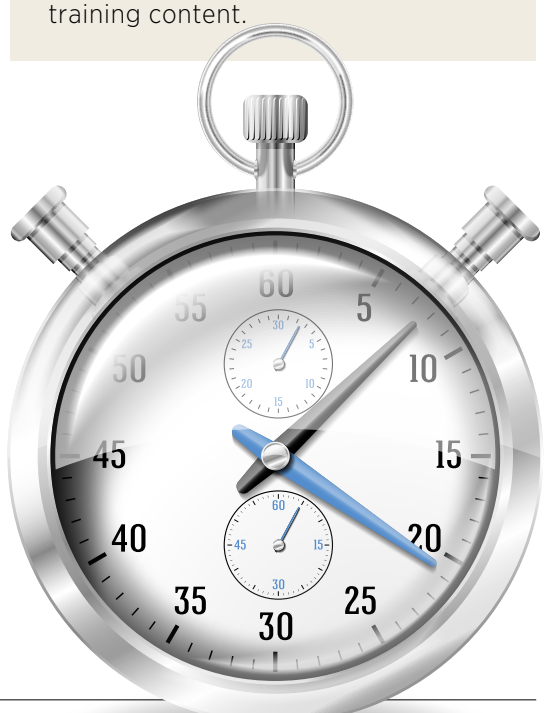
An important suggestion from discussions with business executives with a personal expertise on biodiversity is to develop executive training on environmental topics.

The answer to this challenge will be found both within companies with internal training, as well as through executive education. In the very short term, integrating environmental courses in mid-career diplomas such as Masters of Business Administration (MBAs) is recommended, in order to ensure that people on track to become corporate executives are equipped with the right tools when it comes to biodiversity.

We are aware of the significant effort required to enforce these recommendations. Education institutions could rely on external experts from diverse sectors (private sector, research institutions, NGOs, etc.), and even on their alumni working on sustainability issues. They can be a relevant addition to the academic faculty by bringing a practitioner's view and letting current students envision similar career paths.

KEY LEARNINGS

- Awareness of environmental matters should be fostered through the inclusion of environmental topics (climate, biodiversity, etc.) in curriculums from an early age, notably through in vivo experiences;
- Universities ought to provide interdisciplinary introductions to nature related issues;
- In parallel, specific curriculums will help provide future professionals with the managerial and technical skills to enable the transition;
- The development of executive education on environmental matters will help train the current generation of decision makers;
- The most prestigious institutions should be part and parcel of this momentum;
- NGOs, scientists/experts and alumni with strong knowledge of the matters at hand can help define the right training content.



3. CREATING THE CONDITIONS FOR CHANGE

3.1. More dialogue is required between the scientific community, public authorities, the private sector and civil society

Our discussions with experts show that - as is the case for climate change - the scientific evidence supporting the collapse of biodiversity is already sufficient to trigger decisive action. The development of research in the coming years might lead to adjustments to the scale of specific impacts, the discovery of specific linkage effects, or deepen our knowledge on ecosystems recovery or resilience, but it will not change our direction of travel.

As is the case with the climate crisis, science shall be the bedrock of any strategy designed to tackle the loss of biodiversity. Relying on the broad scientific evidence already available is required to achieve the most efficient use of resources at our disposal.

Science, be it about understanding ecosystems or modelling the underlying risks, will be especially important in the context of non-linearities associated with the materialisation of risks related to biodiversity: **conventional risk models with a backward looking approach may not be able to factor in mechanisms such as tipping points whereby overshooting a threshold can have irreversible effects even if at a later time levels fall back below the threshold**.

Hence funding should be directed to research projects, by both public and private institutions. These endeavours can also benefit from what has already been done with regards to climate change - see for instance the work of the Network of Central Banks and Supervisors for Greening the Financial System (NGFS) on climate scenarios and stress-testing, and the exploratory study of the Banque de France on biodiversity risks.[102]

Biodiversity issues exhibit more idiosyncrasies than climate change, requiring deep analysis at the local level and the expertise not only of economists but also of doctors, biologists, etc. - there is no one-size-fits-all metric (*e.g.*, CO_2 emissions for climate change) as discussed further on in the part on measurement.

As underlined above about the social challenges associated with the transition, it remains paramount to include the contribution of a broad spectrum of scientific fields in order to have a holistic and efficient approach. These especially include the contributions from economics and social sciences, or philosophy.

After an initial focus on physical aspects of climate change, policymakers quickly realised it would be key to broaden the approach in order to achieve the transition, which led to the concept of just transition, now sitting at the centre of policy debates. The March 2022 report of the IPCC[103] notably included to a broad extent the contributions of scientific disciplines other than climate science, enabling a better understanding of the vulnerability of human societies.

[102] *Svartzman, R., Espagne, E., Julien, G., Paul, H. L., Mathilde, S., Allen, T., ... & Vallier, A. (2021). A 'Silent Spring' for the Financial System? Exploring Biodiversity-Related Financial Risks in France. Banque de France Working Paper No. 826.*

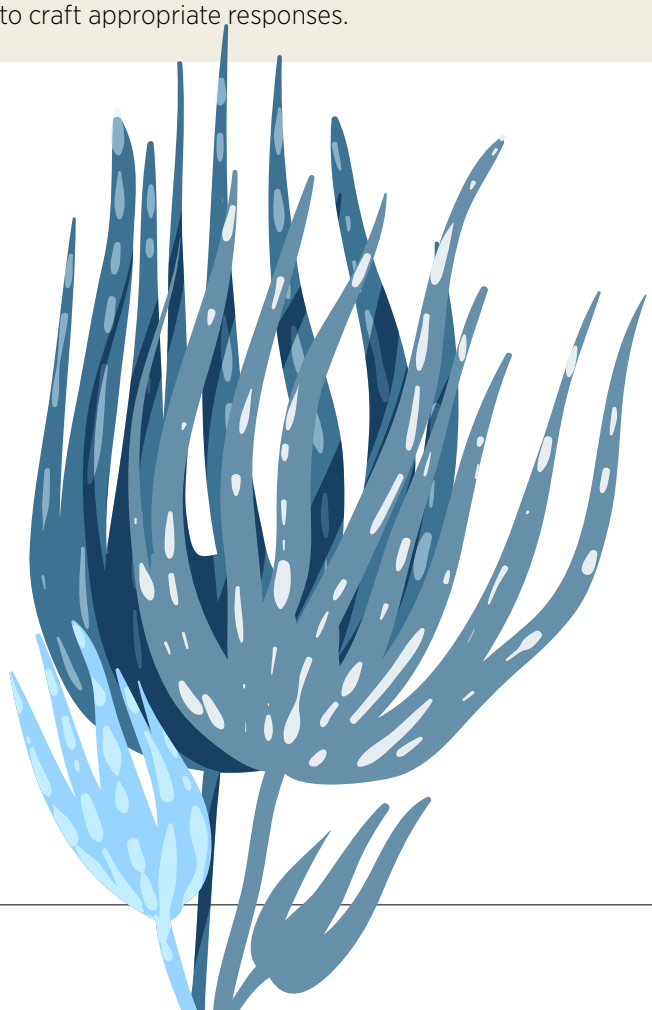
[103] *IPCC. (2022). Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. In Press.*

An important - yet little-discussed - development from our discussions with experts is the importance of biodiversity specialists to engage in the public debate, in which science is a major contributor, but in which other considerations also need to be taken into account.

The philosophical, ethical and societal issues which biodiversity raises should be openly debated, relying on the facts brought to light by science.

KEY LEARNINGS

- The conclusions and progress of science ought to fuel decision-making, both for public bodies and companies;
- Scientific research needs to be supported through long-term funding to deepen knowledge on biodiversity and look for mitigation and adaptation solutions;
- The input of a broad spectrum of scholars, coming also from economics, social sciences, and philosophy should be factored in;
- A "parallel track" approach is favoured, in which action is taken on the basis of the currently available body of knowledge, while continuing to intensify our scientific knowledge;
- Forums are needed in which scientific experts, business leaders, NGOs and policy makers are in a situation to interact and work together to craft appropriate responses.



3.2. Several measures of biodiversity are being developed, and will support change

Metrics to measure biodiversity are needed to support action

First, it is worth noting that measuring the presence and intensity of life entails significant ethical debates, which are beyond the remit of this report. Nevertheless, there was a broad consensus among our interviewees that a better understanding of the pace of biodiversity loss and of the impact of human activity on this loss was advisable to guide our response.

The multidimensional nature of biodiversity is a challenge to the definition of a single metric

We observe in the case of biodiversity an exacerbation of broader challenges already observed for the standardisation of non-financial data. The exacerbation comes from the multiplicity of issues included in the notion of biodiversity, which makes it inherently difficult to measure in a holistic manner.

A first debate lies in the choice between seeking a unique global indicator for measuring biodiversity and the persistence of several specific indicators. In theory, having a unique indicator facilitates comparability across firms and improves decision making within firms to help tackle the challenges and the assessment of the impact and progress made by companies by third parties (states, regulators, NGOs, investors). It would also allow states to make quantitative commitments at the international level that are comparable and integrate more dimensions of biodiversity than current indicators.

Additionally, a single, aggregated metric could foster a more holistic view of biodiversity, and avoid an "anecdotal" approach Without such a metric, there is a risk of actions being judged with limited ability to measure their scale, impact, and unintended side effects. This may be the case, for instance, of efforts to promote regenerative agriculture, which need to be assessed both on their merits, but also on the scale at which they are brought.

On the other hand, biodiversity is a complex and multifaceted question, and it may not be possible to encapsulate its various worthy components into one single indicator. Additionally, due to multiple challenges, there is a consensus that no global metric is sufficient to drive a policy agenda at the company or economy level. In that respect, there is a strong difference between biodiversity and climate change for which CO_2 equivalent emissions are becoming a convenient go-to indicator.

> **"The question is not about the indicator per se, it is about the fact behind the assessment"**
>
> **Gilles Vermot-Desroches,**
> Corporate Citizenship Senior Vice President, Schneider Electric

In addition, measuring an aggregated biodiversity metric could prove challenging for several firms; this would notably be the case for smaller companies, which are likely to find it difficult to measure such a metric.

Lastly, biodiversity has a strong local component, especially when compared to greenhouse gas emissions:

- The causes of biodiversity loss may be localised;
- The impacts could also be very local;
- An apparently comparable loss of biodiversity may have a different significance depending on its location, and interactions with several other factors (climate, economic and social fabric, etc.).

Several aggregated metrics have been developed, which are useful for reporting and measuring biodiversity trajectories.

First, a common vocabulary is fundamental: metrics do not cover the same concepts as indicators, although they are linked - as is explained in the following table.

There are two main systems of aggregated metrics around biodiversity integrity coexisting at the moment:

- The Mean Species Abundance (MSA), based mostly on literature published by the PBL[104] around the GLOBIO model;[105]
- The Potentially Disappeared Fraction of Species (PDF), used in most of Life-Cycle Analysis models (for example, ReCiPe and LC Impact).

Regardless of the metric debate, which concerns experts of biodiversity footprinting and measurement, companies and financial actors should focus on choosing the most appropriate indicator(s) to monitor their impacts on biodiversity. These indicators can either address biodiversity integrity (through PDF or MSA metrics) or address pressures on biodiversity (as detailed in part I, corresponding to the 5 main pressures identified by the IPBES).

Table 4 Concepts, definitions and examples around biodiversity footprinting metrics

Concept	Definition	Example
Metric	Measurement system for a particular value	m^2.MSA or PDF.m^2.yr (see below)
Method	Scientific reasoning that can be described, for example in a scientific article	Scientific article, presentation documents, etc.
Tool	System allowing to apply the method, in a more or less easy way	A specific excel file, or a more elaborated tool available on the internet, etc.
Indicator	Result of the application of a method, that can be used to support decision-making	km^2.MSA per M EUR of turnover for example

Source: Finance For Tomorrow. (2022). Finance et biodiversité. L'écosystème français. Retrieved from: https://financefortomorrow.com/app/uploads/2022/03/F4T-Finance-Biodiversite-lEcosysteme-francais.pdf

[104] *The Environmental Assessment Agency of the Netherlands*

[105] *See https://www.globio.info/*

Several methods and tools use these metrics to assess the biodiversity footprint of economic activities, as detailed in a very exhaustive report published by the EU Business@Biodiversity Platform in 2021.[106] In particular, we underline:

- Life-Cycle Assessment methodologies that are specifically designed to address biodiversity loss;
- The Global Biodiversity Score®, developed by CDC Biodiversité, can be used by companies and financial actors to assess biodiversity impacts all along their value chain, covering most of the pressures exerted on biodiversity;
  - The methodology is deployed by Carbon4Finance to commercialise a database BIA-GBS® assessing listed equities;
  - More than 20 analysts have been trained by CDC Biodiversité to use the tool and work with companies and financial actors to assess biodiversity impacts;
- The Corporate Biodiversity Footprint, developed by the fintech Iceberg Data Lab, can be used for the same targets=
  - Data is sold by Iceberg Data Lab to financial actors;
  - The method has been selected by a consortium of investors after a call for interest in 2020 (the four historical partners being AXA IM, Mirova, BNP Paribas AM, Sycomore AM);
- The Biodiversity Footprint for Financial Institutions, developed by the Dutch bank ASN Bank with the support of Pré and CREM consulting groups. It uses the PDF metric and adopts a life-cycle approach.

Consistently with *the Science-Based Targets for Nature* recommendations, an interesting approach is to first look at the materiality of impacts throughout the value chain using sectoral assessment tools, identify hotspots and prioritise challenges, then assess the baseline impact possibly through MSA or PDF and set targets, then act and report. Targets can be fixed with several metrics, addressing ecological integrity,species abundance, species richness or level of pressures, depending on the chosen scope.

A pragmatic approach should promote immediate action without hampering the search for more aggregated metrics

An important outcome of our discussions is that the debates over measurement should not hinder the global effort to take action: we should focus not so much on the precision of the proverbial thermostat but rather on bringing the actual temperature down, and

> **"Indeed for biodiversity, contrarily to climate, there is no unique method to measure biodiversity impacts for companies. But we know some actions that work: stop deforestation, and stop grasslands and wetlands conversions. If we managed to achieve this, it would solve a significant portion of the problem".**
>
> **Alain Vidal,**
> Consulting Professor, AgroParisTech and Former Technical Director; Science-Based Targets Network

[106] *Lammerant, J., Starkey, M., De Horde, A., Bor, A.-M., Driesen, K. and Vanderheyden, G. (2021). Assessment of biodiversity measurement approaches for business and financial institutions. Update Report 3. https://www.business-biodiversity.eu/bausteine.net/f/9722/EU_B%40B_Platform_Update_Report_3.pdf?fd=0*

consequently, on actions that can be taken to avoid biodiversity loss.

Several experts insisted that we already have enough indicators and measures to evaluate within a reasonable degree of precision the causes and extent of the damages to biodiversity. For instance, while it may not be possible to know precisely the biodiversity footprint of a company, there is a broad consensus that deforestation and land conversion are one of the main drivers of biodiversity erosion, and that companies should focus on limiting deforestation and land conversion.

It may be more relevant to identify, for each sector, 3 - 5 key indicators which would capture the most significant impacts of this sector on biodiversity. Indeed, our discussions with both experts and companies indicate that the most relevant metrics may differ among sectors, as a consequence of the different ways they impact biodiversity. These indicators could evolve and be refined over time, as data builds up. This means that several biodiversity metrics could coexist depending on the economic sector, underlying policy objectives (*e.g.*, global awareness and prioritisation vs. corporate strategy and action plan). Nevertheless, the major drivers of biodiversity loss would find their way to these metrics, which would help convergence over time.

> **"One shouldn't wait for all to be measured to act, but let's measure to understand the share of responsibility of each stakeholder"**
>
> **Antoine Cadi,**
> Head of Research and Innovation,
> CDC Biodiversité

Improving data quality over time will be key, in order to foster reliability and trust

As is generally the case with ESG[107] reporting, the quality of data is at least as significant as the definition of the appropriate metrics.

The fact that data may not be satisfactory in the first instance should not come as a surprise, nor as an invalidation of the need to measure impacts over time. Building quality data takes time, and this is even more true in the case of such a multidimensional phenomenon as biodiversity loss.

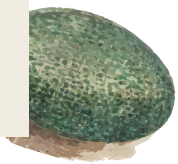
Importantly, disclosure requirements expected from companies should be consistent with those imposed on investors and financial institutions, in order to promote a coherent disclosure framework.

This problem may be addressed over time through a better standardisation of reporting frameworks, on the one hand, and potentially third party certification providers on the other - which notably the TaskForce on Nature Related Disclosures is helping to define.

[107] *Environmental, Social, Governance.*

KEY LEARNINGS:

- The development of relevant metrics is needed to better measure and decrease the negative impact of countries and companies on biodiversity;
- The definition of comprehensive metrics is more complex for biodiversity than for climate, but a few metrics take up the challenge;
- A pragmatic approach should be promoted, through which a few key indicators should be defined for each sector, covering their most significant biodiversity impacts. These indicators would then be refined over time;
- This would not prevent the definition of more comprehensive biodiversity indicators, which could notably be used by the financial sector;
- In parallel, while indicators and metrics are being refined, actions should already be taken to prevent biodiversity loss;
- The improvement of biodiversity data over time is an important objective. The imperfection of this data should not be a hindrance to action, nor an invalidation of the overall approach. The gradual standardisation of reporting, as well as the consistency between the requirements of investors and issuers, will create a common vocabulary between all parties;
- Biodiversity impacts will remain more local than in the case of GHGs. Consequently, engagement at the local level will need to be encouraged



3.3. Bringing life to the boardroom: corporate governance should gradually include biodiversity considerations

Raising awareness of sustainability issues at the board level is a major lever of change

The involvement of the board is all the more relevant as environmental matters impact the competitive and regulatory framework and business model of most businesses.

Several possibilities can be considered to enhance board awareness and ownership of environmental and biodiversity topics, including:

- Extend the remit of boards to encompass environmental matters, generally and/or in the context of mission-driven companies. Certain legal frameworks already provide for this possibility. French law broadens the mandate of boards to include environmental considerations such as biodiversity[108], while creating the possibility for companies to become "missiondriven" ("entreprise à mission") or to adopt a "raison d'être" which can be encapsulated in a company's articles of association;
- Foster the upskilling of board members on environmental and biodiversity topics, through training, and/or the identification of directors with a particular competence on the matter.

The development of sustainability reporting should naturally bring about such an awareness, notably for listed companies.

Awareness at the executive level, and of all teams can be fostered by regulation, board involvement, training and appraisal structures

Obviously, the enlisting of the executive team is of the utmost importance to onboard companies. The training initiatives for non-executive directors as mentioned in part 2.3. are equally applicable to executives.

In addition, specific key performance indicators (KPIs) can be included in the roadmap of executives, either through regulation or board decisions. These KPIs can also be reviewed to determine executive compensation. For larger companies, notably if they are listed, such KPIs are increasingly scrutinised by investors, in addition to operational and financial indicators.

Beyond boards and executives, it will be key to ensure awareness and ownership by all relevant teams. Climate change and more broadly environmental, social and governance issues have been supported by dedicated sustainability teams. This is most often necessary in order to have advocates within the company. Over time, sustainability principles should filter through all departments and teams. This can be done, again, through training and the inclusion of sustainability KPIs in objectives, evaluations and eventually, compensation.

"The topic of biodiversity needs to go beyond the sustainability / environment teams of companies (*e.g.* internal audits and reporting): operations and financial directions should be aware of the ecological footprint of their activities"

Harold Levrel
Researcher in Ecological Economics, CIRED.
Co-director, Ecological Accounting Chair. Professor, AgroParisTech and Paris-Saclay University.

[108] *See Article L. 225-35 of the French Commercial Code.*

It is notably important to alert strategy and finance teams to the definition and monitoring of non-financial considerations. We are already observing this trend with climate-related reporting being handled more and more by finance departments for large companies.

As mentioned above, an efficient way to involve the finance department is to first approach biodiversity issues from a risk perspective and measure the exposure to the loss of biodiversity in terms of profitability, as detailed in Part I. This can trigger a recognition of the materiality of biodiversity for the company and lay ground for broader awareness of the impact of the company on biodiversity.

Human resources teams obviously play a critical role in giving sustainability topics a central role in the company's culture: through training, as mentioned above, but also the hiring and evaluations processes.

KEY LEARNINGS

- Embarking companies on a transformation journey requires an alignment of all stakeholders;
- Board awareness can be improved, through regulatory changes and/or dedicated training. Increasing shareholder involvement is also proving, notably for listed companies, to be a strong driver of change;
- Awareness and accountability of the executive team can be fostered via trainings, as well as specific KPIs on environmental matters;
- Beyond the board and executive team, sustainability considerations should gradually filter through to all teams. The strategy, finance, and human resources departments are of particular relevance to attend to this transformation.

3.4. A method for change in the corporate world

> **"What we need is a method for change"**
>
> **Bertrand Badré,**
> Managing Partner and Founder
> Blue like an Orange Sustainable Capital

While this comment has broader ramifications, including on the global governance of biodiversity issues, it resonates strongly with several of the discussions we had with corporates who are engaging in transformations to protect biodversity. Given the complexity of the matter, difficulty to generate useful and reliable data, and the ongoing work on climate change and GHG emissions in many organisations, knowing how and where to start can be challenging.

Thanks to the interviews with experienced biodiversity experts and advocates within companies, we were able to gather some interesting and very practical guidelines on how to best start working on biodiversity. We are sharing them humbly, being very cognizant that this cannot be comprehensive.

HOW DO I START

#1: IF NO ONE CARES, NO ONE DARES

A key – and sometimes first – step is to raise awareness. This does not mean that fundamental work cannot start before, or in parallel; to the contrary, in many companies who have engaged on the topic for years, significant work has been carried out by a handful of passionate, curious individuals.

But awareness is critical, notably at the highest level of the organisation: it triggers attention, creativity, and budgets.

POTENTIAL ACTIONS:

- Train the Board and executive team: some companies have brought a biodiversity specialist to a company event or an executive committee retreat for a dedicated workshop;
- Make this a graphic, sensorial experience: biodiversity can be so immersive, while many of the objects of corporate life are dematerialised. Observing and learning about biodiversity in a meadow or a forest can be as convincing as discussing it in the board room;
- Work with NGOs or biodiversity experts, such as the teams presenting the fresque de la biodiversité;
- Present the compelling facts about biodiversity;
- Use this report!

#2: ONBOARD BEYOND THE BOARD

Engage teams beyond the executives and the board. In several cases, the biodiversity cause was actually spearheaded by enthusiasts before being endorsed by the top management.

POTENTIAL ACTIONS:

- Encourage initiatives on the topic of biodiversity;
- Send a message from top management that biodiversity – and other environmental matters – are considered key by management, and welcome thoughts on how to engage on the topic;
- Include biodiversity in the training curriculum of the teams, starting with awareness raising and accompanying interested individuals;
- Create environment/sustainability/biodiversity ambassadors;

#3: FRAMEWORKS WORK

Several frameworks are being developed to approach the topic of biodiversity. While most are in the making, they provide a useful place to start and apply to various business models.

POTENTIAL ACTIONS:

- Review and test the frameworks being developed to address biodiversity, notably:
- The SBTN framework[109] ;
- The TNFD LEAP framework[110] ;
- Leverage on an existing sustainability / environment framework: for companies with an existing and well-known sustainability framework, it may be efficient to adapt it to include biodiversity. This approach should not overlook the specificities of biodiversity; its main advantages are to facilitate appropriation by teams as well as a gradual inclusion of biodiversity as metrics develop.

#4: YOU CAN'T FIX WHAT YOU CAN'T SEE

Measuring dependencies and impacts on nature is critical to triggering and monitoring action. A biodiversity assessment, or audit, is one of the best starting points. It allows for an understanding of how the company interacts with ecosystems, across its entire value chain. This assessment can be done internally, or with the help of specialised firms.

POTENTIAL ACTIONS:

- Conduct a biodiversity assessment[111], or include biodiversity in your assessment;
- Connect with sector organisations, who may have a framework to propose.

#5: START SOMEWHERE

The definition of key performance indicators is critical to the definition, communication, and monitoring of biodiversity objectives. Yet, this definition is a complex exercise, in light of the multidimensional nature of biodiversity, the only recent awareness of the topic, and the limited amount of data available at this stage within most companies. Consequently, while working on refining the thermometer is important, this work should not deter from actions to save the patient.

Starting off with a few simple, albeit imperfect, indicators is a very pragmatic approach, allowing to kick-start the process of engagement, assessment, and action. This means identifying a few simple indicators which are relevant to the business and its impact on biodiversity. Drawing a parallel with the operational and financial information that a board typically focuses on, one of our interviewees suggested selecting 3 to 5 indicators which are understandable, and visible. This allows to engage the board, the executive management, and the teams on a set of measures, targets and actions which the whole organisation understands.

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[109] *https://sciencebasedtargetsnetwork.org/*

[110] *https://tnfd.global/*

[111] *Examples of such assessment frameworks include: the Global Biodiversity Score® by CDC Biodiversité, Ecosystem AnalytiQs by Quantis, Corporate Biodiversity Footprint by Iceberg Data Lab, STAR by IUCN, ENCORE by UNEP-WCMC, etc.*

POTENTIAL ACTIONS:

- Ideally following an audit / assessment, select a limited number of KPIs to monitor impact on biodiversity;
- These KPIs should be:
- Reasonably simple to understand;
- Relate to immediately apprehendable impacts, eg. land footprint, freshwater use, etc.
- Cover the main impacts of the company on biodiversity, and not be anecdotal;
- Present limited overlap with each other. For instance, for certain companies, GHG emissions and energy consumption probably overlap significantly;
- Actionable, ie allow the teams to act on them, either immediately or in the medium turn, once business models or processes have been transformed;
- Communicate these KPIs broadly, to create understanding and ownership.

#6: DON'T BE AFRAID OF IMPERFECTION, AND FOCUS ON THE 80%

A clear acknowledgement that the KPIs and ability to identify dependencies and impacts have limitations is key in order to move forward. Several companies have started with partial data, partial measurement, and partial actions. They have been able to try, improve their KPIs, develop new actions and improve the existing ones. In parallel, a process to improve the quality of data should be implemented.

The aim should be to work as much as possible on the main drivers of biodiversity impact; this means identifying - even with imperfect data - the few areas of biodiversity destruction linked to the company's activities and focusing on them. Obviously, this criterion has to be cross-checked with feasibility, so as to focus on the areas on which improvement appears possible.

POTENTIAL ACTIONS:

- Start with certain KPIs and themes, using the two criteria of (i) importance of the impact on biodiversity, and (ii) feasibility;
- In parallel, refine the objectives, actions, and pursue the identification of other sources of impact.

#7: WORK ON CLIMATE CHANGE

As has been presented, climate change is a significant driver of biodiversity loss. As a consequence, actions to prevent GHG emissions are paramount to the preservation of biodiversity.

POTENTIAL ACTIONS:

- Iif not already in place, implement a climate change / GHG emissions reduction plan.

#8: MONITOR AND FOLLOW UP

Monitoring of the KPIs is critical to measure progress; it can also indicate that some KPIs are not relevant, well defined, or need to be supplemented.

POTENTIAL ACTIONS:

- From the start, set up a process to monitor progress;
- Use this process to adjust actions in the most effective way.

#9: BE AHEAD OF YOUR CLIENTS

One topic which came up during discussions with some experts is: should companies merely follow client demand, or proactively implement biodiversity policies and devise processes, products and services addressing the issue at stake? Companies aim at responding to customers' demand. However, some of the most transformational shifts in business have been brought about by companies innovating (not only on technological innovation, but also on business models, processes, etc.) ahead of their customers.

One interesting example is Tony's Chocolonely, a chocolate bar company which entered the Dutch industry with a very simple claim to move towards a slave-free chocolate bar. It has become the largest brand in the market, and gained recognition as one of the most sustainable brands in the country.[112] Consequently, companies have a capacity to bring change, raise awareness, and promote more sustainable processes, products, services, and behaviours, even if client demand is only looming.

- Proposed action: anticipate behavioural change by promoting proactively more sustainable processes, products, and services with clients.

#10: CONNECT

Embarking on such a new topic can be both exciting and discouraging, notably as the urgency of the matter increases the stakes. There are several benefits to connecting: leveraging on already existing frameworks, accelerating the identification of dependencies and impacts, sharing tools and best practices, etc.

POTENTIAL ACTIONS:

- Contact experts and NGOs working on and with the industry to identify tools and practices;
- Use already existing frameworks whenever available;
- Connect with industry organisations to leverage on already identify analyses, tools and frameworks;
- To the extent possible, cooperate with other stakeholders in the industry to develop mutually beneficial solutions.

[112] *Kraaijenbrink, J. (2019). How to bring sustainability to the masses: Tony's Chocolonely's impact strategy. Retrieved from: https://www.forbes.com/sites/jeroenkraaijenbrink/2019/11/08/how-to-bring-sustainability-to-the-masses-tonys-chocolonely-impact-strategy/*

Box 4

Science-Based Targets for Nature

Following the 2015 Paris Agreements on climate, the Science-Based Targets initiative (SBTi) established itself as the reference for climate target setting certification. As we write this report, nearly 3,000 large companies have committed to short term (***e.g.*** 2030) climate targets, a process which kicks off with a commitment letter signed by the CEO of the company.

Such success led to the creation of the Science-Based Targets for Nature framework. As for climate, a network composed of NGOs, consulting firms and scientists is defining guidelines on how to measure impacts and set science-based targets on 4 key nature-related dimensions:

- Land: focuses on preventing the conversion of natural habitats and other land-related issues;
- Freshwater: focuses on water scarcity, water pollution and fragmentation of freshwater habitats;
- Ocean: focuses on all ocean-related issues (*e.g.* plastics, fisheries, pollution);
- Biodiversity: focuses on species, ecosystem integrity and nature contributions to people (NCP).

The framework journey is composed of five steps which guide companies from understanding what are their main areas of impacts, to prioritising action, setting a baseline, and tracking progress.

As scientific knowledge is still in progress, the framework's development is still undergoing and target setting criteria are being defined. Up to now, the land and freshwater "hubs" are the most advanced ones, with pilot projects already at an advanced stage. Target setting criteria for freshwater are expected to be unveiled by the end of 2022.

Nevertheless, companies can already engage in the process by following the first two steps of the framework. These two steps consist in (i) conducting an environmental materiality assessment, mapping the value chain, (ii) and prioritising issues related to the company. This can allow any company to start adapting its environmental strategy (which is often mostly climate-oriented) and focus on its contribution to the most relevant drivers of biodiversity loss.

What's more, and in order to start taking action, the SBTN already unveiled what are called "interim targets", accompanied with guidance for companies and indicators. Targets are broken down in 4 categories: "Avoid", "Reduce and Regenerate", "Restore" and "Transform". These categories express the fact that biodiversity issues should not only focus on impact mitigation but also on restoration and regeneration to see life recovering by 2050 – and achieve a "nature-positive" economy.

"External drivers are necessary to incentivise companies to take more advanced commitments on biodiversity."

Claire Varret,
Senior Biodiversity Advisor, EDF

3.5. Innovation can significantly contribute to biodiversity preservation, but is no silver bullet

Discussions with experts show the potential of innovation (including, but not limited to technological progress) in tackling biodiversity issues. A growing number of companies and academic projects created in recent years purport to better measure biodiversity, assess risks related to its decrease, alleviate pressure on, or restore, biodiversity where damages have been inflicted.

Technology can help measure and monitor biodiversity

Noteworthy examples include the development of biodiversity sensors which could be used by companies and placed in their physical facilities. Through sample collection, eDNA (environmental DNA) analysis technologies identify species present in a given environment. One concrete example is the company Beeodiversity, which has launched a product called Beeomonitoring. It is a tool to measure biodiversity and pollution through the analysis of pollen collected by bees, which act as natural drones and bioindicators. This analysis generates quantitative and qualitative data on the number and type of plant species present, as well as the quantity and concentration of pollutants currently in the environment. Combined, these two data streams can be used to assess the overall quality of the local environment for key species such as insects or birds.

There are also several interesting developments related to the use of satellite images for the monitoring of large areas, *e.g.* for the observation of deforestation risks for which maintaining a presence on the ground might be costly and logistically difficult.[113]

Enabling nature-based solutions can help reduce pressure on the environment

While climate focused technologies are often human centred, biodiversity innovation will go through the enhancement of ecosystems' health, notably to maximise ecosystem services (carbon capture, soil fertility, water purification, pollination…). These innovations vary in nature, from non-technological to highly technological. Their design can require in-depth analysis and engineering to ensure that such processes are well understood and supported in an optimal manner.

The 'nature-based solution' concept has been defined by the IUCN in 2016 as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits".[114] This overarching concept underlines the fact that the 'societal challenges' that our societies are facing (for example, climate change and biodiversity erosion) can be addressed together, relying on natural processes. Yet, because of its very broad definition, it is used sometimes misleadingly - the proposition of an IUCN Standard of Nature-based solutions in 2020 aims at capturing this risk.[115]

Concretely, nature-based solutions can cover projects from spontaneous rewilding to restore for example water filtering capacities,

[113] *See for instance the Global Forest Watch platform and services: https://www.globalforestwatch.org/*

[114] *IUCN. (n.d.). Nature-based Solutions: About. Retrieved from: https://www.iucn.org/theme/nature-based-solutions/about.*

[115] *IUCN. (2016). Defining Nature-based Solutions. Retrieved from: https://www.iucn.org/sites/dev/files/content/documents/wcc_2016_res_069_en.pdf.*

replanting of hedges of local species to host crop protection insects, maintenance of dunes to combat coastal erosion, etc.

Leveraging on innovation and technology to alleviate our impact on biodiversity

Land use and land use change rank among the main drivers of biodiversity loss, notably due to their impact on natural habitats (see part I). Several innovations can contribute to the reduction of an activity's land footprint. Here, we present two examples of innovation (or families of innovations) both alleviating pressure on land and contributing to lower GHG emissions and possibly water use and pollution: alternative proteins and circular economy applied to the textile industry.

• Alternative Proteins

Human population growth is not the only driver of the growth of our land footprint. In fact, **livestock is the major contributor to our land footprint: livestock accounts for a significant part of the total agricultural land occupied, while it provides 18% of the global calorie supply and 37% of the protein supply.**[116] The world counts 21 billion chickens, 1.5 billion cattle, 1.2 billion sheep, 1 billion pigs, 1 billion goats and about 500 million turkeys.[117]

There is however increasing realisation of the possibility to diversify our sources of high quality proteins, notably through leguminous plants. This led to the creation of products by companies like Beyond Meat or Impossible Food which are often called "alternative meat": they purport to recreate the texture, taste and looks of real meat. **Some studies show that a burger made with plant-based alternatives reduces GHG emissions, land use and water use by at least 90%, depending on the products.**[118] Nutritionally speaking, these alternatives may also score better than their meat equivalent, with little cholesterol, a similar concentration of protein, and significantly lower amounts of fat and saturated fat.

Insect-based proteins are also an interesting solution to provide alternative inputs to animal feed, and possibly human protein intake.

Certain public decision makers are also starting to raise the topic of dietary changes in order to achieve net-zero goals and improve public health. In the UK, the government ordered an independent review of the national food strategy. The report suggested to set a goal of 30% meat consumption reduction in ten years[119] and called for the government and companies to nudge consumers into plant-based alternatives, notably alternative meat.

The report also stated that "supermarkets and chain restaurants sell us the majority of the meat we eat. They will therefore have a vital role to play in tempting us to eat more plants and a bit less meat". In that respect, there have been certain announcements in the fast-food industry, promoting meat-free menus and vegetarian offerings, more or less transformative of the menu (some would just add one vegetarian sandwich, others would switch part of the menu).

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[116] *Ritchie, H., and Roser, M., (2013). Land Use. OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/land-use.*

[117] *Ritchie, H., and Roser, M. (2017). Meat and Dairy Production. OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/meat-production'.*

[118] *See for example: Heller, M.C. and Keoleian, G.A. (2018). Beyond Meat's Beyond Burger Life Cycle Assessment: A detailed comparison between a plant-based and an animal-based protein source. Report No. CSS18-10.*

[119] *National Food Strategy. (2021). National Food Strategy: The Plan.*

Yet, several questions remain pending on this topic, notably the products' scalability, consumer willingness to adopt these new consumption habits, and social impacts on the producers' side. Consequently, the impact that these innovations will have on our diet remains uncertain at this stage. Royal Society predicts that alternative proteins could take a 10% market share of the global meat market within ten years[120], but estimates of the scalability potential and consumer adoption of alternative proteins vary greatly.

• Circular economy

Some of the key commodities of our economies are land based, such as pulp and paper, cotton, natural rubber, palm oil (in part not destined for human food) and mining. **Oftentimes, the circular economy is seen as a lever to reduce waste, and efficiently use resources. Rarely is it seen as a way to reduce impacts on biodiversity by diverting land pressure from virgin raw materials to recycled ones** - as no land is required to grow crops for the additional demand. **Just as "avoided CO_2 emissions" have become mainstream, the circular economy can be measured in terms of "avoided land footprint, water consumption and waste**".

There is no doubt that the circular economy offers great potential to reduce carbon and biodiversity impacts. Nevertheless, in some situations, the question remains as to the change of consumer behaviours, *i.e.* to what extent will the circular economy actually reduce first-hand purchases.

The textile industry is an example which demonstrates the great potential of a circular economy, as well as the potential trade-offs and rebound effects. On the one hand, new technologies and business models are allowing the scaling up of recycled materials, with commitments following from major players driving investments. For instance, the H&M Foundation invested USD100 million in a partnership with the Hong Kong Research Institute of Textiles and Apparel to scale technologies such as the recycling of blend textiles into new fibres. In the meantime, Adidas committed to only source recycled polyester by 2024, which not only reduces waste found in the ocean, but also reduces oil consumption and prevents potential transfers of impacts to natural fibres.

Certain studies forecast that by 2030 at the latest, the second hand market will outperform the fast fashion industry.[121] On the other hand, while used items present great reduction opportunities in terms of water and land use as well as GHG emissions per item, they can also lead to unexpected rebound effects: a study from the Boston Consulting Group found that "32% of consumers sell on the second-hand market in order to increase their purchasing power on the first-hand one".[122] If the rise of the second hand market contributes to the rise of fast fashion, a great environmental opportunity will be lost.

Moreover, **second hand platforms can contribute to increasing the rate of personal clothes rotation**, leading to increased transportation and reinforcing the trend that fast fashion built among consumers: that clothes can be treated as disposables. To meet biodiversity goals, the textile industry will need to promote more sustainable, and repairable clothing (Levi's marketing seems to go in this direction). In such a paradigm, clothes would be made to last, and reused for longer periods of time, therefore reducing land demand and environmental footprint from the sector.

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[120] *The Royal Society. (2019). Future food: health and sustainability - Conference Report. Part of the conference series 'Breakthrough science and technologies. Transforming our future'. The Royal Society.*

[121] *thredUP. (2021). Resale Report. Retrieved from: https://www.thredup.com/resale/*

[122] *Boston Consulting Group. (2019). Luxe de seconde-main, un marché à 12% de croissance par an.*

Technology is unlikely to suffice to dealing with biodiversity loss

While technology can be a contributor to the preservation of biodiversity, its potential does not, on its own, guarantee a positive impact. While there is no doubt that innovation and technological progress will be needed to address this challenge, relying on it solely will not suffice to dealing with the entirety of the issue at stake.

Certain analyses also point to the potential unintended adverse effects of such technologies, as the March 2022 IPCC report[123] mentions in the case of carbon capture: the existence of promising technologies should not delay decisive action.

Innovation to prevent biodiversity loss and promote restoration can be partly non-technological (*e.g.*, low tech innovations, innovations in the fields of finance or accounting, with ecological accounting frameworks) and partly social. The examples of the circular economy and alternative proteins show that these changes rely on acceptability and new ways of living which are viewed as attractive both financially and socially. In that regard, technological scalability for biodiversity needs to be thought of with a holistic approach encompassing the network of infrastructure and user-friendliness in which any innovation will be integrated. This is where social sciences will play a key part.

Lastly, the ability of innovation to scale up depends on:

- The development of infrastructure and incentives enabling such scalability;
- The availability of financing to fund such innovation.

KEY LEARNINGS

- Innovation to halt biodiversity loss and enhance restoration can be broken down into different categories (biodiversity monitoring to inform action and decision making; nature-based solutions that rely on the interactions with ecosystems to provide benefits to society; technological and non-technological developments that help divert or reduce impacts);
- Alternative protein sources and the circular economy are examples of innovations which can provide significant biodiversity benefits;
- Innovation should be analysed through the lens of its impact on the environment, to avoid adverse effects (*e.g.*, an innovation addressing climate change with negative impacts on biodiversity);
- Rebound effects must be taken into account or minimised to reach net positive impact.

[123] *IPCC. (2022). Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. In Press.*

4. ACTIVATING CHANGE IN ALL SECTORS

4.1. A tailor-made approach to act on the whole value chain

A significant finding from our various discussions is the need to factor in the specificities of each sector in the way it impacts biodiversity. This is obviously true also for GHG emissions; but accentuated in the case of biodiversity, and results from:

- The multidimensional aspect of biodiversity: as a consequence, each sector will impact - and benefit from - biodiversity in a different manner: through land use, water consumption, release of toxic compounds into the atmosphere or in soils, etc.;
- The highly local nature of interactions, requiring an analysis of the localisation of a particular sector, company or plant, as well as a more detailed analysis of the natural habitat being impacted.

As a consequence, a detailed analysis of the value chain of each company, and each sector is required to assess their impact and dependency on biodiversity.

In addition, our interviews clearly indicate that the solutions that companies can implement often require cooperation among various stakeholders in sectors or supply chains, such as:

- Vertical collaborations, eg, between suppliers and manufacturers: to allow farmers to make investments towards a more sustainable model, large purchasers can commit to buying farmers' harvests for several years;
- Horizontal cooperation, to define sector-wide standards or best practices.

As indicated, these can be examined either via the lens of sectors or supply chains. An example is the textile industry, which depends partially on agriculture.

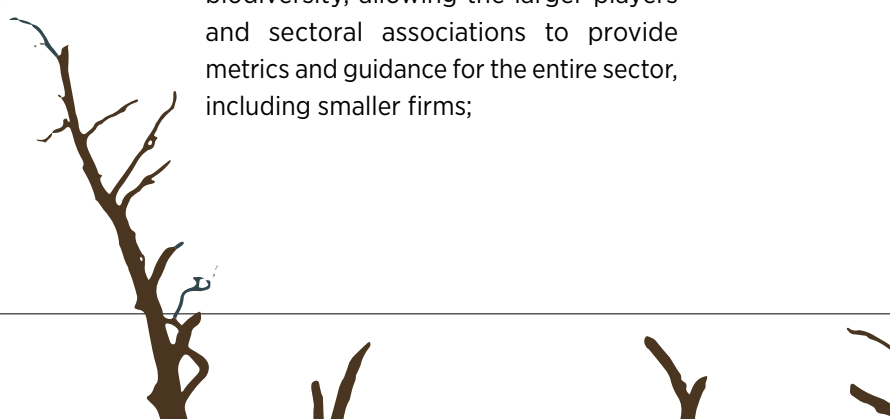
This supports the view that a sector and/or supply chain approach should be helpful to assess and tackle the biodiversity challenge. This is reinforced by the existing organisation of the corporate world in sectors.

Such an approach is even more key to enlist SMEs. Large corporations have the means and resources to:

- Analyse their impact and dependencies on biodiversity;
- Envision potential mitigation and remediation actions;
- Discuss with experts and regulators.

This is clearly not the case for SMEs. As a consequence, there is a risk that large groups would take commitments or positions which would impact their smaller suppliers (or clients) without a clear understanding of the spillover effects on these suppliers or their ability to face them. To enlist SMEs on this transformation path, several actions can be undertaken:

- Maintaining and increasing funding to organisations providing research, training and directly usable material to guide SMEs in the transformation;
- Fostering a sectoral approach to biodiversity, allowing the larger players and sectoral associations to provide metrics and guidance for the entire sector, including smaller firms;



- The involvement of regional and local authorities, to ensure coordination on a specific geographical area.

However, several corporate leaders indicated that the dialogue within sectors and supply chains still lagged behind compared with what would be needed to address some of the environmental challenges. This dialogue should be fostered, through:

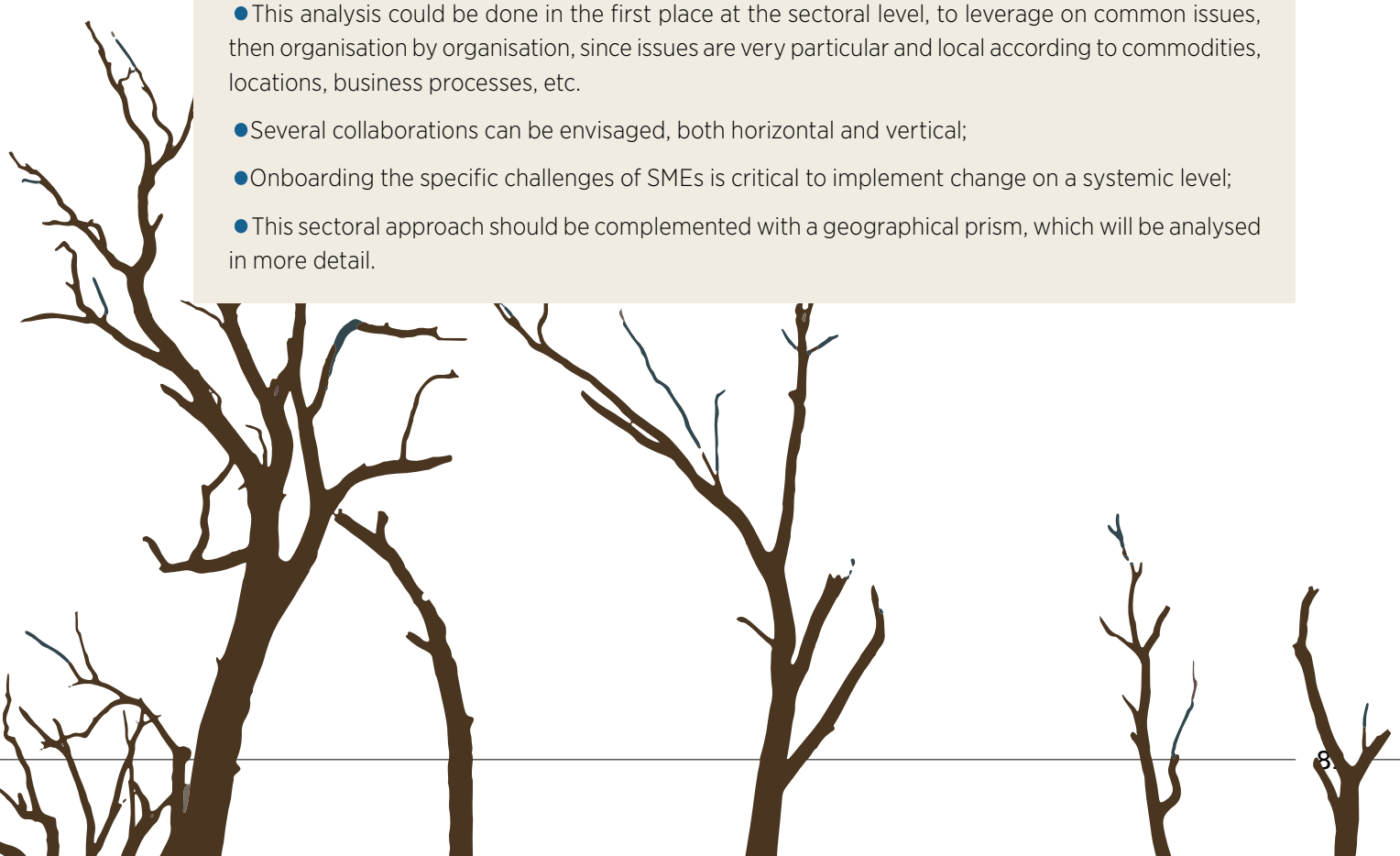
- Sectorial forums of discussions, including biodiversity experts;
- Sectorial coalitions;
- A close dialogue with smaller players of the sector and value chain, to apprehend their own challenges and ability to withstand change.

We will also see that a geographical prism is relevant, given the highly local nature of ecosystems and biodiversity impacts.

With the broad challenges faced by societies and businesses in mind, this part of the report delves deeper into issues pertaining to specific sectors - the ones we were able to discuss about with the most experts and business executives. It is by no means exhaustive. Notably, our work related to the construction and energy sectors is very much preliminary and the complexity of underlying issues would require additional discussions with experts to gather meaningful recommendations - discussions which we were not able to conduct within a constrained time frame.

KEY LEARNINGS

- An understanding of the impacts and dependencies on biodiversity through the value and supply chain is paramount to be able to identify and tackle the biodiversity challenge;
- This analysis could be done in the first place at the sectoral level, to leverage on common issues, then organisation by organisation, since issues are very particular and local according to commodities, locations, business processes, etc.
- Several collaborations can be envisaged, both horizontal and vertical;
- Onboarding the specific challenges of SMEs is critical to implement change on a systemic level;
- This sectoral approach should be complemented with a geographical prism, which will be analysed in more detail.



4.2. Agriculture and food production are key to tackle the life challenge

As indicated in Part I of this report, agriculture is tightly intertwined with biodiversity:

- **It is highly dependent** on living species and ecosystems;
- **It has a significant impact** on biodiversity, through the conversion of natural areas, notably to monocultures with little on-field biodiversity, the use of fertilisers and pesticides, the change of landscapes (*e.g.*, less hedges and trees on plots), the use of water, and the GHG emissions that may occur both on field (methane, nitrous oxide, notably) and from fuel consumption;
- **It is a key part of the solution** to biodiversity erosion, and can be a major force for changing and fostering life to flourish.

The food industry, which sits downstream to agriculture, is equally important in this instance:

- **It is major purchaser of agricultural products**, and can consequently promote the transition to a more sustainable model;
- **Being close to the customer**, it also plays a leading role in changing consumption habits, including through information and education;
- **The food sector is also a link between agriculture and health**.

The discussions we had with experts pertained primarily to agricultural models in mature economies. The specificities of emerging markets would require further discussion and analysis, to take into account their economic, social and environmental context.

The urgency to act calls for the activation of mutually beneficial levers to reverse the sixth mass extinction. There are three main levers of change:

- Change in production models;
- Change in consumption patterns and therefore diets;
- Reduction of food waste at the production, distribution, and consumption levels.

> **"With our current model and demography, we are bound to cross planetary boundaries. There are 3 overarching solutions to bring us back within boundaries: shifting diets, changing our agricultural model, and reducing losses and wastes."**
>
> **Alain Vidal,**
> Consulting Professor, AgroParisTech and Former Technical Director; Science-Based Targets Network

These levers are tightly intertwined, as the evolution towards more regenerative production models requires a change in dietary habits to stabilise and possibly lower land use and pressure.

A change in production models to limit their impact on biodiversity and the environment as a whole

- **Biodiversity in agricultural value chains means more diversity in species cultivated, diversified agricultural models.**

In order to provide sufficient food and agricultural products to an increasing population, we have significantly standardised agrarian systems: seeds, agricultural practices, rotations, harvesting, landscapes (*e.g.* less

hedges and trees) etc. This standardisation had several objectives:

- Enable larger outputs;
- Facilitate farm management by standardising fertilisers and pesticides application practices
- Help downstream integration into the food industry;
- Enable the standardisation of products to end clients;
- Lower prices.

Technical progress was then largely focused on these objectives.

Fertilisation strategies on the field are in part led by the demand of downstream buyers for standardised commodities. One striking example heard in our interviews was the dynamic generated by the industrialisation of bakeries, dependent on high-gluten wheat to facilitate such transformations. To meet these requirements farmers are using higher amounts of fertilisers. Therefore, asking them to reduce the use of fertilisers implies that the downstream part of the value chain has to adapt.

"The simplification of farms upstream is also a consequence of downstream industries (mostly in the food sector) for example, large-scale bakeries need very normalised types of flour to work."

Sébastien Treyer,
Executive Director, IDDRI

Reinstating the complexity and sophistication of ecosystems can significantly contribute to biodiversity preservation and restoration

This has several benefits:

- Increase in biodiversity;
- More stable and resilient ecosystems: more on-field biodiversity allows to increase resilience to climate events, local pressures, diseases, pests, etc. This includes the protection and restoration of ecosystems, the sustainable use of soil and water resources, agroforestry, diversification of farming systems, various adjustments in cultivation practices and the use of stress tolerant crops and crop improvement.[124] For forestry, tree species react differently to disturbances around them - for example, deciduous trees drop their leaves for winter which makes them less vulnerable to winter storms than evergreen trees. Thus, mixing tree species for forestry plantations is a solution to mitigate the impacts of disturbances.[125]
- Lower dependency on one type of crop, hence a diversification of the risk associated to this particular type;
- Increased customer satisfaction, who will enjoy a larger range of fruits and vegetables depending on the season and the origin of these products.

[124] *Mijatovic, D., Van Oudenhoven, F., Eyzaguirre, P., Hodgkin, T. (2013). The role of agricultural biodiversity in strengthening resilience to climate change: towards an analytical framework. International Journal of Agricultural Sustainability 11(2): p. 95-107 ISSN:1473-5903[1].*

[125] *Forest Information System for Europe (n.d.). Resilience: Vitality. Retrieved from: https://forest.eea.europa.eu/topics/vitality/resilience.*

Recomplexifying systems and productions can therefore be encouraged for the benefits of all. This includes for instance:

- Growing more various and resilient local varieties;
- Recomplexifying landscapes;
- Introducing and developing new crops;
- Developing and financing downstream infrastructures (varied grain silos, adaptation of industrial transformation processes, etc.). This development will require the creation of new infrastructure and the transformation of existing ones, such as the equipments that were designed for large scale monoculture.

The live experimentation of a diversified farm in market gardening in Le Bec-Hellouin in France (Normandy) serves as an interesting example to illustrate the possible gains with such a transition. This couple of farmers tried to diversify the plants grown, relying only on ecosystem services and interactions to deal with pests and funghis and reintegrate fully on field biodiversity. Research on their farm reveals that it is possible to earn a living with such practices. Several of our interviewees highlighted that the scalability of these practices was key, and increasingly confirmed.

"Agroecology and agroforestry do not only work for small surface areas. In China, the World Bank led an agroforestry project of 4 million hectares."

Monique Barbut,
President, WWF France

- **Revisiting the use of chemical products would limit impacts on biodiversity**

The impact of chemical products (*e.g.* fertilisers, pesticides, herbicides) on soil, water, and species is more and more documented (see part I for more details).

These impacts can be lessened through firstly the decrease of the use of synthetic fertilisers and pesticides/herbicides, and secondly the improvement of application practices when they cannot be avoided.

Therefore, in order to lower the use of chemical products throughout the value chain, organic and regenerative agriculture should be scaled up.

- **The promotion of organic and regenerative agriculture should contribute to biodiversity, and a more sustainable agricultural model**

"We are lacking robust agronomical frameworks for the agricultural transition. Until now, practices have mostly been evaluated empirically: farmers would base themselves on what has been done by others, but it does not necessarily mean that it is the right solution for their specific context."

Rachel Kolbe Semhoun,
Head of Sustainability, InVivo

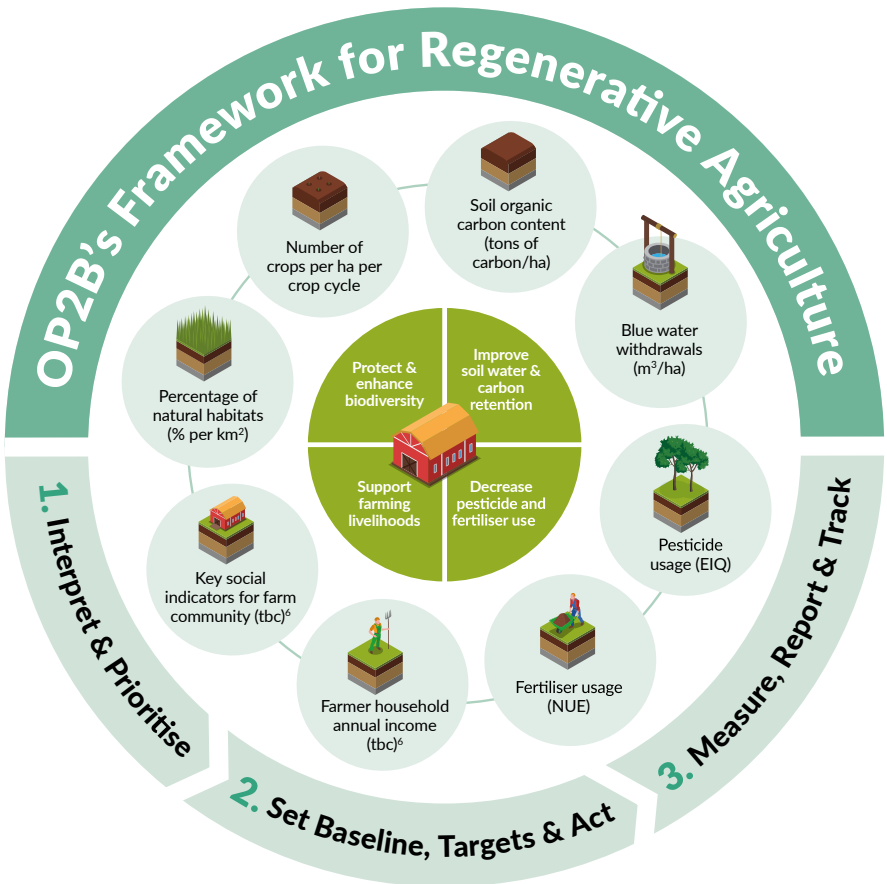
Regenerative agriculture is a modern type of agriculture that builds upon the environmental benefits of organic agriculture, but goes further to adopt a more holistic point of view. According

to the OP2B framework[126], regenerative agriculture is a set of farming and grazing practices focusing on:

- Protecting and enhancing biodiversity at and around farms;
- Improving or preserving carbon and water retention in the soil, leveraging the power of plants, livestock and agricultural practices;
- Enhancing the resilience of crops and nature, while decreasing pesticide and fertiliser use;
- Supporting the livelihoods of farming communities.[127]

Up to now, regenerative agriculture did not have a precise definition supported by dedicated indicators. The OP2B coalition, presented below, initiated a work to align actors on a set of indicators that would allow to meet these four objectives.

Figure 13. OP2B's framework for regenerative agriculture



Source: OP2B. (n.d.). Scaling up regenerative agriculture - OP2B's contribution. Retrieved from: https://op2b.org/wp-content/uploads/2021/09/OP2B-Regenerative-Agriculture-Leaflet_FINAL.pdf

[126] *OP2B. (n.d.). Scaling up regenerative agriculture - OP2B's contribution. Retrieved from:https://op2b.org/wp-content/uploads/2021/09/OP2B-Regenerative-Agriculture-Leaflet_FINAL.pdf.*

[127] *OP2B. (n.d.). Scaling up regenerative agriculture - OP2B's contribution. Retrieved from: https://op2b.org/wp-content/uploads/2021/09/OP2B-Regenerative-Agriculture-Leaflet_FINAL.pdf.*

One Planet for Business and Biodiversity (OP2B) is a sector-wide coalition supporting regenerative agriculture that has caught significant attention

We had the privilege to interview its former Managing Director, Florence Jeantet, now Chief Sustainability Officer at Danone. Other interviewees, contributed to enriching our point of view.

OP2B was founded at the instigation of Emmanuel Faber, former CEO of Danone, and was under the spotlight at the United Nations Climate Action in 2019 where nineteen large companies joined the coalition.

The purpose of the coalition was to protect and restore biodiversity within their supply chains.

Three overall objectives structure OP2B's action:

- Scaling up regenerative agriculture practices to promote soil health;
- Reducing dependence on a handful of crops by boosting cultivated biodiversity and diversifying product portfolios;
- Eliminating deforestation and enhancing the management, restoration and protection of high value natural ecosystems.

Key Success Factors:

- Senior leadership, both at the OP2B level and by CEOs. CEO sponsorship of these new sustainability topics appear key to enlist the whole organisationy;
- Value chain approach through a wide coalition: diverse types of stakeholders representing all stages of the value chain, including downstream actors which are key to make farmers' transition workable, as well as enablers (*e.g.* data companies such as Google and Microsoft, or financial players such as BNP Paribas or Mirova);
- Inclusion of farmers in the elaboration of the model from the onset.

Social & environmental expected benefits:

- Soil health, improved water retention, reduced pesticides use;
- Increased soils' carbon storage and reduced carbon emissions (lower fertiliser use);
- Improved on-field biodiversity and increased crops' genetic diversity;
- Farmers' livelihood support.

Contribution to the transition's scaling up

- Alignment: 8 metrics were defined to provide a framework for regenerative agriculture, which had a broad definition preventing its development;
- Case studies: about twentytest programs across most continents, for various crops and multiple industries (cosmetics, personal care, food and beverage), proving regenerative agriculture can be achieved in a few years without necessarily sacrificing yields after a 3 to 5 year transition period;
- Critical mass: enough investments and engagement of stakeholders on the whole spectrum of the supply chain enables the transition to kickstart more rapidly;
- Financial resources: OP2B and its members commit to channel large financial resources to regenerative agriculture projects. Nestlé has announced investing more than EUR1billion in these agricultural practices over the next five years. Such investments are a key success factor, as they alleviate the financial burden on farmers, who do not necessarily have the ability to bear such investments.

"Coalitions are useful but no panacea. Transition will come by supporting companies in transformative changes within their value chain."

Florence Jeantet,
Chief Sustainability Officer, Danone

The second challenge is preventing that future growth in food demand leads to deforestation and conversion of natural habitats

"OP2B is a first step, it provides a framework that should bring transitioning farmers better market access for their diversified crops. Lack of access can be a major deterrent for farmers which adds to the risk of changing his or her practices."

Rachel Kolbe Semhoun,
Head of Sustainability, InVivo

Deforestation and more largely land-use changes have led to the destruction of natural habitats. Most of this deforestation occurs in the tropics, while tropical forests are among the most biodiverse ecosystems alongside wetlands, meadows, savannas, coral reefs and mangroves. Agriculture has been found to be one of the main drivers of these land use changes, notably through the production of soybean, palm oil, beef, cocoa, coffee, natural rubber, wood products, etc., which are key commodities in human diets and industrial supply chains.[128]

A shift in agricultural production models should be accompanied by a shift in consumption patterns

In Western countries, dietary patterns are evolving, and a societal debate is emerging

Meat consumption has been increasing globally. Global meat consumption reached 322mt in 2017, and is very unequally distributed geographically: about 47% comes from Asia (out of which 27% for China, and 2% in India), 19% from Europe including Russia, 13% North America, and 15% South America, and less than 6% from Africa.[129] In parallel, the consumption of fish and marine products is rising across the world, both in absolute terms and per capita.[130]

The FAO estimates that 70% more animal products would be needed by 2050 in a business as usual scenario, which could create significant pressure on land use.[131]

[128] *Ritchie, H. (2021). Cutting down forests: what are the drivers of deforestation? OurWorldInData.org. Retrieved from: https://ourworldindata.org/what-are-drivers-deforestation. and Goldman, E. D., Weisse, M., Harris, N., & Schneider, M. (2020). Estimating the Role of Seven Commodities in Agriculture-Linked Deforestation: Oil Palm, Soy, Cattle, Wood Fiber, Cocoa, Coffee, and Rubber. Technical Note. World Resources Institute, Washington, DC. and Curtis, P. G., Slay, C. M., Harris, N. L., Tyukavina, A., & Hansen, M. C. (2018). Classifying drivers of global forest loss. Science, 361(6407), 1108-1111.*

[129] *INRAE (2019). Quels sont les bénéfices et les limites d'une diminution de la consommation de viande ? Retrieved from: https://www.inrae.fr/actualites/quels-sont-benefices-limites-dune-diminution-consommation-viande*

[130] *FAO (2020). The state of world fisheries and aquaculture 2020. Sustainability in action. FAO, Rome.*

[131] *FAO (2018). More fuel for the food/feed debate. Retrieved from: https://www.fao.org/ag/againfo/home/en/news_archive/2017_More_Fuel_for_the_Food_Feed.html?platform=hootsuite.*

However, in Western countries, the debate around the level of meat consumption is gaining momentum, notably among younger generations. It is driven by several considerations: environmental impact, health, and animal well-being notably.

Moreover, meat consumption has been decreasing in some European countries, as illustrated by FAOStat Data: for instance, in the Netherlands, Germany and France, the total amount of meat consumed per capita has reduced respectively by 29%, 12% and 11% between 2010 and 2019.[132] In France, consumption has been decreasing across all social categories. Interestingly, younger generations (18-24 years old) rank among the highest consumers of meat, notably via transformed products.[133] According to Kantar Worldpanel, a third of French households count a flexitarian (ie, who has significantly reduced their animal product intake), while veganism remains marginal (0.5%).[134]

These trends are accompanied by the rise of alternative proteins (whether they are plant- or, more recently, insect-based) which are more deeply analysed in the innovation section of this report.

Yet, the European Union's consumption of meat per capita is still almost double that required for our nutritional needs[135], and emerging economies are gradually following such a lifestyle, a phenomenon sometimes called the "westernisation of diets". In France, diets rely today on more than 70% animal based proteins.[136] On the other hand, the reduction of animal protein intake requires caution, notably for populations with specific dietary needs (children, the elderly, notably).

The impact of animal breeding on the environment is clearly identified by science

Animal breeding produces GHG, notably CH_4, N_2O, and CO_2 contributing to climate change. At the global level, total GHG emissions attributed to livestock (direct and indirect, notably including the transportation of livestock) amount to 14.5%[137] of those attributed to human activities, equivalent to more than 80% of those generated by transportation.[138]

From a biodiversity standpoint, the impacts of livestock breeding and meat consumption are notably linked to:

- Water consumption (even though the vast majority of water used is rainwater, which is not directly used for other purposes[139]);
- Pollution (*e.g.* nitrate, pesticides used on feed crops);

[132] FAO stat, Domain: Food Balances, Element: Food Supply Quantity, Items: all types of meat except aquatic.

[133] Based on data from 2016, see: Tavoularis, G. and Sauvage, E. (2018). Les nouvelles générations transforment la consommation de viande. Consommation et modes de vie n°300. CREDOC.

[134] Kantar Worldpanel France (2016). Le "flexitarisme", une tendance en vogue. Retrieved from: https://www.kantarworldpanel.com/fr/A-la-une/flexitariens-nl48.

[135] Westhoek, H., Rood, T., van den Berg, M., Janse, J., Nijdam, D., Reudink, M., Stehfest, E. ... & Woltjer, G. B. (2011). The protein puzzle: the consumption and production of meat, dairy and fish in the European Union (No. 500166001). PBL Netherlands Environmental Assessment Agency.

[136] Barbier, C., Couturier, C., Dumas, P., Kesse-guyot E., Pharabod, I., ADEME. (2020). Empreintes sol, énergie et carbone de l'alimentation. Partie 1: empreintes de régimes alimentaires selon les parts de protéines animales et végétales. 33p.

[137] Gerber, P.J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Falcucci, A. & Tempio, G. (2013). Tackling climate change through livestock – A global assessment of emissions and mitigation opportunities. FAO, Rome.

[138] Based on 2019 IEA Figures, see: IEA (2021), Tracking Transport 2021. IEA, Paris. Retrieved from: https://www.iea.org/reports/tracking-transport-2021

[139] INRAE (2019). Quels sont les bénéfices et les limites d'une diminution de la consommation de viande ?
Retrieved from: https://www.inrae.fr/actualites/quels-sont-benefices-limites-dune-diminution-consommation-viande.

- Land use change and consequently, deforestation. In the European Union, soy and beef originating from Brazil, Argentina or Paraguay are respectively the top 1 and top 3 commodities in terms of imported deforestation. Soy is mainly used to feed livestock and poultry, while extensive practices for beef production in these countries often replace tropical forests. This amounts to the conversion 89,000 ha per year for soy, and 27,700 ha per year for beef of tropical forests. All-in-all, the EU would be responsible for 16% of the deforestation associated with international trade, behind China (24%), ahead of India (9%) or the US (7%).[140] Oil seeds production used to feed poultry and pork are also a driver of nature loss.

As has been clearly indicated, stopping land use change and deforestation and protecting the richest soils and ecosystems (wetlands, meadows) are a priority for both climate and biodiversity. The issue is that two key factors will tend to increase pressure on land:

- Demand for agricultural products is on the rise globally, including meat and fish;
- Switching from conventional agriculture to more biodiversity-friendly practices (*e.g.* regenerative or organic farming), while having local environmental benefits could contribute to increase land conversion and deforestation risks if it requires a higher amount of land to reach the same level of production (in the short term at least, in the long term more biodiverse fields may be more resilient to droughts and extreme events and benefit yields).

As a consequence, reducing the land demand for agricultural products is key.

Rebalancing diets is needed to protect biodiversity while ensuring the development of emerging economies

Globally, livestock consumes about one third of the cereals produced.[141] In the European Union, about two thirds of the cereals consumption (including international trade balances) is allocated to animal feed, not human food. Another 5% is allocated to industrial uses (often fuel) in the EU.[142]

Other parameters should be kept in mind before jumping to conclusions:

- Land directly used for beef production are in majority meadows, which only a fraction could be converted to croplands, as many of these lands are located in places that cannot be cultivated (*e.g.* mountains).
- Livestock rearing uses about one third of the cultivated surface, to produce feed for animals.[143]
- Cereals allocated to livestock are not necessarily usable for human food and are considered "co-products". A study from the FAO establishes that about 86% of the cereals allocated to livestock are currently not eaten by humans.[144]

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[140] *WWF. (2021). Stepping up? The continuing impact of EU consumption on nature worldwide. Summary report.*

[141] *Mottet, A., de Haan, C., Falcucci, A., Tempio, G., Opio, C., & Gerber, P. (2017). Livestock: On our plates or eating at our table? A new analysis of the feed/food debate. Global Food Security, 14, 1-8.*

[142] *Based on data from the FAO; see graph from Our World in Data (2020). Cereals allocated to food, animal feed and fuel. World. OurWorldInData.org. Retrieved from: https://ourworldindata.org/grapher/cereal-distribution-to-uses?country=~OWID_WRL.*

[143] *INRAE (2019). Quels sont les bénéfices et les limites d'une diminution de la consommation de viande ? Retrieved from: https://www.inrae.fr/actualites/quels-sont-benefices-limites-dune-diminution-consommation-viande.*

[144] *Mottet, A., de Haan, C., Falcucci, A., Tempio, G., Opio, C., & Gerber, P. (2017). Livestock: On our plates or eating at our table? A new analysis of the feed/food debate. Global Food Security, 14, 1-8.*

In conclusion, meat does have a role to play in food security, as well as in the preservation of both climate and biodiversity, as the latter are a key part of the meadows ecosystems. As stated in part I, meadows are essential ecosystems when it comes to carbon storage and reaching net-zero, as long as they do not replace tropical forests. The question remains, as often when dealing with planetary boundaries: **where does the equilibrium stand?**

> **"Shifting diets is the keystone to free up the space needed to feed humans, produce energy and expand protected areas."**
>
> **Baptiste Perrissin Fabert,**
> Executive Director,
> Expertise and Programs, ADEME

Several analyses present scenarios on how to rebalance diets at the global and European levels:

- INRAE and CIRAD have developed different scenarii (Agrimonde-Terra foresight) to feed 9.7bn individuals in a sustainable way by 2050. One scenario is based on land use for food quality and healthy nutrition scenario. This "healthy" scenario is based on several pathway drivers, such as the stabilisation of global warming or the healthy diets based on food diversity (see full list in cited report). It also induces a reduction of the consumption of animal products in developed and emerging economies, compensated in part by an increase in developing regions. Overall, this "healthy" scenario is " the less agricultural land-using compared to other Agrimonde-Terra's scenarios » and is « the only scenario allowing to feed in a healthy way the growing world population while limiting agricultural land expansion and deforestation at the world level".[145, 146]
- The Ten Years for Agroecology scenario (TYFA) developed by the IDDRI suggests a reduction of 40% in animal production both in terms of calories and volume.[147] If it still represents a great reduction in consumption, keeping parts of animal production could allow to maximise the carbon storage potential of European meadows, to which herbivores constitute an essential component. Meat consumed would also be of better quality.

In Europe, such changes should enable the development of extensive practices that aim to maximise meadows' potential (contributing to increase carbon storage), while extending plant-based protein cultivation and scaling up organic or regenerative agriculture.

[145] *Le Mouël, C., Marajo-Petitzon, E., Dumas, P., Manceron, S., Forslund, A. and Mora, O. (2016). Agrimonde-Terra foresight: Land use and food security in 2050. Technical report. Scenarios' simulation results. https://www.inrae.fr/sites/default/files/pdf/agrimonde-terra-resultats-de-simulation-des-scenarios-en-anglais.doc.pdf.*

[146] *Two variants of this scenario are explored. Scenario C assumes « the "Sustainable intensification" pathway for cropping systems and the "Agroecological livestock" pathway for livestock systems; while scenario D « involves the "Agroecology" pathway for cropping systems and the "Agroecological livestock" one for livestock systems ». Under these parameters, the total area dedicated to agriculture increases at the global level with both variants, but very little with scenario C (+29 million ha: + 85 million ha of pastureland, - 56 million ha of cropland globally) and a little more with scenario D (+ 269 million ha: + 50 million ha of cropland and +219 million ha of pastureland globally). Consequently, even this scenario leads to some deforestation, but significantly less than in the others explored (-63 million ha in case C variant, 279 million ha in case D.*

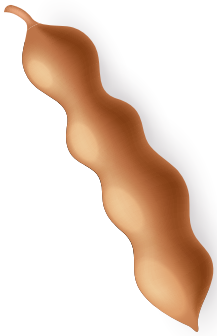
[147] *Poux, X. and Aubert, P.-M. (2018). Une Europe agroécologique en 2050: une agriculture multifonctionnelle pour une alimentation saine. Enseignements d'une modélisation du système alimentaire européen, Iddri-AScA, Study N°09/18, Paris, France, 78 p.*

Finally, and considering the current consumption trends in the world as of now, what science and our interviewees suggest is that a health and environmental optimum would be the global convergence towards a balanced diet between plant-based protein and animal based protein.

Both companies and governments have a key role to play to nudge consumers to promote a cultural shift. For the private sector, a wider and better plant-based product offering, as well as a dedicated marketing effort could enable such changes both in mature and emerging markets. Through education, public procurement, regulation and financial incentives/disincentives, public authorities can also contribute significantly.

Supporting farmers in this transition

In the short-term (especially a transition period of 3 to 5 years), the change in agricultural practices may induce lower yields (*e.g.* tree planting for agroforestry systems may reduce total area under cultivation for the crop at stake), requiring financial support for farmers from downstream actors. In the long run, these changes could instead increase yields, as on field biodiversity and resistance to weather hazards increases.



- **Recognising the central role of the farming community in this transition**

During our discussions with experts and business executives, the farming community stood out as central in the evolutions necessary to preserve and restore biodiversity. These evolutions can have significant repercussions for farmers, both in terms of training, investments, practices, and economic models. Supporting them through this transition is both needed and fair.

Farmers have fulfilled a role that was assigned to them over time by industrial societies: ensuring the stable provision of food at affordable costs, with increased standardisation and a wide range of choices. These societal choices enabled a drastic reduction of starvation worldwide and led for example Europe to become one of the main exporters of agri-food products.

These impressive results were achieved through significant technological advancement, mechanisation of, and changes in, agricultural practices, as well as significant investments. This change was particularly marked during the 20th century and since the 1950s.

Through the evolutions being contemplated, farmers can, again, play a pivotal role in one of the main challenges that our societies are facing: protecting our environment, improving our health, while supporting the growth of populations.

This role cannot be fulfilled without the recognition of farmers' contribution to our common well-being, and the associated support. An orderly and just transition is warranted, in which the farming community is associated and supported.

- **Several players can support farmers in this transition**

Public authorities' engagement is key, both through subsidies and through the regulatory power - beginning with a de-indexation of the Common Agricultural Policy on the number of hectares, to halt the consolidation and enlargement of farms, a trend not in favour of the conservation of biodiversity.

> **"We have to create financial mechanisms for the agricultural transition of the same magnitude than what we did for renewable energy"**
>
> **Antoine Denoix,**
> CEO of AXA Climate

Private companies, and especially the ones in the food value chain, can support the transition by building long-term partnerships with farmers to de-risk the changes in practices, accompanied when necessary by public incentives (public-private partnerships);

> **"Biodiversity issues require long-term contractualisation."**
>
> **Xavier Laureau,**
> Co-manager, Fermes de Gally

Financial institutions must be involved as well. Their role is discussed more in depth below.

> **"We need to create the conditions for a convergence of financial support. However, a 15% return on investments in agroecology transformation projects is unlikely."**
>
> **Bernard Giraud,**
> President & Co-Founder,
> Livelihoods Venture

Reducing waste throughout the supply chain would reduce GHG emissions and impacts on biodiversity, while improving food supply to populations

Our interviewees also underlined inefficiencies in agricultural value chains, about one third of global food production for human consumption being lost or wasted.[148] The global carbon footprint of food waste, excluding land use change, has been estimated at 3.3 Gt of CO_2 equivalent in 2007. If integrated into a country ranking of top emitters, food waste would appear third, after the USA and China.[149]

> **"If food waste was a country, it would be ranked third in terms of carbon emissions".**
>
> **Denis Machuel,**
> former CEO, SODEXO

[148] *FAO. (2011). Global food losses and food waste – Extent, causes and prevention. FAO, Rome.*

[149] *FAO. (2013). Food wastage footprint: impacts on natural resources: summary report. FAO.*

Box 5

THE LIVELIHOODS FUNDS

The Livelihoods Funds are impact investment funds with a EUR300 million capacity, created in 2011 by 21 private companies and investors. They joined forces with the aim to restore degraded natural ecosystems, build sustainable supply chains and improve the livelihoods of rural communities who are the most vulnerable to the consequences of climate change. The funds are worth highlighting as they demonstrate four key components of the biodiversity stakes:

- Integrating biodiversity approaches to carbon sequestration goals within companies' GHG emissions offsetting is paramount;
- Switching to regenerative agriculture requires long term investments and commitments (5-10 years), as well as local cooperation with NGOs on the field;
- Tackling the social component of the transition by addressing small farmers' economic balance is a key priority to reduce incentives to deforestation;
- Not only preserving, but also restoring biodiversity is of paramount importance.

A threefold mission: preserve biodiversity, combat climate change, improve livelihoods

The Livelihoods Funds use two complementary levers:

- **Impact finance**, in the form of impact investment funds which are used to prefinance Livelihoods' projects;
- **Skills and expertise**: Livelihoods Venture is responsible for identifying, structuring, and supporting the projects that are implemented by local partners, who in most cases are local NGOs with strong roots in rural communities. The Livelihoods Venture team provides the expertise of agronomists, foresters, carbon experts, financiers, and company managers. Hailing from Europe, Asia, Africa, and Latin America, they have extensive experience of field operations and managing complex projects.

The Livelihoods Funds include two types of funds, the Livelihoods Carbon Funds which leverage the carbon economy, and the Livelihoods Fund for Family Farming, which supports committed brands to sustainably transform their supply chains, for the benefit of nature, biodiversity, and people.

About the Livelihoods Carbon Funds

The Livelihoods Carbon Funds invest in large scale projects to restore natural ecosystems, preserve biodiversity, promote sustainable farming practices and renewable energies. All this while improving the standard of living of rural communities.

Three Carbon Funds were set up in 2011, 2017 and lately in 2021 with an investment capacity of 150 million euros. These investments target community based solutions for the restoration of natural ecosystems, agroforestry, and regenerative agriculture.

In this 3rd Carbon Fund, financial investors join forces together with corporates in the same investment vehicle to accelerate climate action, biodiversity preservation and deliver social impact at scale.

Farmers do keep their property rights: the fruits of the Livelihoods projects belong to the local communities. They can keep the production from their forests, farms, and fisheries for themselves and sell it on.

The Livelihoods Fund for Family Farming (L3F)

The Livelihoods Fund for Family Farming was created in 2015 at the initiative of Danone and Mars Incorporated. This fund was born out of the belief that the preservation and restoration of biodiversity, climate change and rural poverty are interlinked. It adopts an innovative approach to transforming companies' supply chains while at the same time improving the lives of smallholders.

Regenerative agriculture to support soil health & biodiversity preservation

L3F invests in large scale regenerative farming projects (up to 10 year projects) to improve the quality and traceability of products, preserve soil biodiversity and the natural ecosystems surrounding the plots.

The fund focuses on raw ingredients which are mainly produced by smallholders in Asia, Africa and Latin America and are strongly impacted by environmental, economic, and social factors. They include cocoa, milk, palm oil, vanilla, coconut, and shea nut. L3F also works to protect water resources, by preserving drainage basins

Our interviewees also underlined that food waste does not occur in the same way depending on the geographic markets and the sectors considered.

In developing economies, the losses tend to happen at the production and distribution stages of the supply chain, and are linked to agricultural and harvesting techniques, as well as storage, and transportation technologies. However, there tends to be very little food waste at the consumer level. On the contrary, mature economies can be very efficient in the production and distribution processes but the waste on the consumer end is much more significant.

In mature economies, food waste happens in several areas of the downstream chain: restaurants, retailers, company canteens, hospital canteens, etc. The factors underpinning waste vary from one distribution channel to the other, and require detailed analysis. For instance, the high variety of choices coupled with the desire to maintain similar meals throughout the year in restaurants leads to both higher GHG emissions (through significant amounts of imported products), and higher waste.

Interviewees indicated that the industry has started to consider the issue seriously, and that when tackling food waste, significant progress can be made in a few years (up to 50% according to our discussions).

Further improvement can be achieved through:

- Systematic analysis of value chains;
- Financial incentives being further strengthened, including via regulation;
- Customer education.

"Today we do not pay food according to its inherent value"

Denis Machuel,
Former CEO, SODEXO

The rationalisation of choices on restaurants' menus (including canteens) is an important lever of action. This requires changes in practices and client education: the impact on client satisfaction (less choice) can be mitigated by increasing the rotation rate between products. In other words, proposing a smaller menu but changing more often.

The evolution of consumer behaviour is a strong catalyst for change

Citizens, as consumers, can play a significant role in this transformation, by favouring higher quality products. Obviously, the situation of lower income households should be taken into account, to promote access to quality food for all.

KEY LEARNINGS:

- Scaling up agricultural models that are less reliant on synthetic fertiliser inputs and chemicals is a significant lever of biodiversity preservation;
- Food waste can be reduced significantly, both in mature and in emerging economies;
- Consumers can contribute notably through a gradual shift in diets in favour of more balanced diets between plant-based and animal based proteins;
- Increasing the variety of crop species and changing practices requires adaptation of the downstream supply chain infrastructure;
- Supporting farmers through this transition can be done by adapting public subsidies, appropriate funding mechanisms, and via the engagement of the whole value chain actors in coordinated operational coalitions.

4.3. Other sectors: construction & energy

Our discussions on the construction and energy sectors were more high level and preliminary than those pertaining to agriculture and finance. We acknowledge that further work is needed to have a more comprehensive understanding of the biodiversity challenges faced by these two sectors.

Some early takeaways from discussions with interviewees already brush a picture of two sectors exhibiting important similarities. These similarities are notably explained by the importance of energy infrastructure in analysing the impact of the energy sector on biodiversity.

However, differences also emerged notably related to the structure of these sectors: the energy sector is reasonably concentrated, with notably some large integrated players, while the construction sector is more scattered with stakeholders of various sizes along the value chain. In order to create the conditions of a dialogue on biodiversity topics, sector wide initiatives are consequently needed, taking into account the diversity of stakeholders in the sector.

We list below our first learnings related to the impact on and exposure to biodiversity of the construction and energy sectors.

Construction and Real Estate

As explained in the first part of the report, the construction sector has a strong influence on two drivers of biodiversity loss: artificialization of soils, and climate change. The negative impact comes from residential and commercial buildings alike.

The main adverse impact of the construction sector is due as much to its land footprint, replacing natural ecosystems with artificial buildings as to its upstream value chain (production of building materials). Assuming human societies will still rely on a network of physical buildings and infrastructures in the foreseeable future, the question becomes that of finding a compromise between physical biodiversity boundaries and the necessary development of infrastructures to cater to the needs of a growing population – underlining once more the deep intertwining between biodiversity and societal issues.

Additionally, the sectoral challenges are especially acute when it comes to energy and water consumption during the initial construction process, requiring in any case a holistic approach to value chains associating quarrying and cement companies.

Circularity is crucial in this industry, to avoid further land degradation due to quarries' development. On a second level, when reuse or recycling is not possible, exploitation techniques of quarries should be as less polluting as possible. Whenever damages are not irreversible the rehabilitation of quarries should be a priority for the sector, coherent with the focus on mitigation. It can yield significant results in terms of biodiversity restoration.

The measurement of biodiversity – and especially loss of biodiversity – is identified as an important challenge for the construction sector, given the fact that individual buildings are spread geographically. It entails the development of a network of sensors that would enable centralised organisations – such as real estate companies handling hundreds of buildings – to monitor the evolution in real time and implement timely action if need be. The question of the in-situ biodiversity is posed to these real estate companies: research is ongoing on the 'urban biodiversity' and the integration of urban and natural environments.

An initial outcome from discussions with experts is that while renovation efforts on existing buildings can yield significant biodiversity improvements (notably via avoiding upstream impacts of materials and direct impacts of land artificialisation), the main focus should be on earlier planning and initial construction. These first steps have a lasting impact – especially on the artificialization of soils – which cannot be corrected completely by ex-post modifications.

Developing these long-term strategies will first require support of multi-stakeholder initiatives gathering all actors of the construction sector as well as public bodies. In France, 16 companies launched in November 2021 the Biodiversity Impulsion Group under the aegis of the Observatory of Sustainable Housing. It is expected to catalyse the discussion around biodiversity in the real estate sector with deliverables such as measurement tools and cartography initiatives to sketch out the local contributions to biodiversity. These results should be confronted with an integrated value chain approach integrating upstream impacts of building materials and downstream impacts due to energy consumption and water management inside buildings.

Additionally, long-term strategies will need to be translated into the financial structure of the broader construction sector, with whenever possible the generalisation of longer period contracts. This is a requirement to enable actors

to engage in the transition with important shifts, thus avoiding untenable economic and financial uncertainty. Additionally, the improved visibility will facilitate the development of education and training programs in relation with these policy objectives.

Energy

Like the construction sector, the energy sector is impacting both the climate change and the land use change drivers of biodiversity loss.

The land use dedicated to energy production is twofold. On the one hand, from a biodiversity point of view, fossil energy sources are often located in very rich ecosystems As a consequence, the extraction of resources is likely to have significant negative impacts on these fragile ecosystems. The problem is reinforced by the fact that these resources are often located in low-income countries, where fossil resources represent locally a significant source of revenues and where there is a lack of environmental safeguards

On the other hand, the gradual transition to renewable energy sources is triggering important debates on the artificialization of soils in the areas where windmills or solar panels are installed. It has become a key aspect of the environmental strategies of the renewable energy producers we discussed with, as they are increasingly faced with NIMBY backlashes at the local level, whether or not for environmental concerns.

Interestingly, interviewees noted that they feel their efforts related to biodiversity are not yet properly factored in their interactions with public bodies, such as tender offers or ratings. This is in opposition with climate change where the use of CO_2 emissions metrics have facilitated the change.

Important trade-offs are appearing between climate and biodiversity in the energy sector, which will need to be resolved both from a scientific and political perspective. A notable illustration of these trade-offs is the issue of biofuels.

Interviewees stressed once again the importance of sector-led coalitions in moving the transition of the energy sector forward. They argue that positive movements initiated by multi-stakeholder coalitions can give biodiversity experts additional leverage in their discussions with the top management of companies. A healthy competition to be best performers as regards biodiversity is gaining traction.

KEY LEARNINGS:

- The construction sector impacts biodiversity both through land use change (artificialization) and climate change (energy use for material production);
- The energy sector impacts biodiversity mainly through the same drivers: artificialization of soils by energy infrastructure, and CO_2 emissions;
- The drivers of biodiversity loss vary among the subsectors (upstream vs downstream, construction vs real estate management), requiring a value chain approach to factor in all externalities;
- The governance of the transition will be different for the energy and construction sector, with the former rather concentrated and the latter more scattered.

4.4. Marine biodiversity calls for a specific approach

Ocean biodiversity is a central part of life on the planet, a pillar in the fight against climate change, and a necessity to maintain our ability to feed ourselves in the long run.

While we favoured a sectoral approach in our analysis, it appeared necessary to look at the ocean in a holistic way, in order to highlight the specificities of marine biodiversity. Obviously, the fishing industry is of particular relevance to marine life; however, other major contributors to its decline, such as chemical and plastic pollution, needed to be addressed as well.

One issue to be discussed - beyond this report - is the best governance to deal with marine biodiversity. While we do not believe that we are in a position to conclude on this topic, it seems possible to articulate the various prisms of action in a coherent way: the sectoral approach to the fishing industry, the issue of plastic waste, and more regional / local action.

Biodiversity in the ocean, critical for humanity, is in peril due to anthropogenic pressures

Oceans cover about 70% of the Earth's surface and is home to 25% of all non-bacterial species found on Earth.[150] While many species have been described, ocean biodiversity could be underestimated today, and a large part of it has yet to be discovered, particularly in deep waters. Ocean biodiversity is of paramount importance, as it provides key ecosystem services (*e.g.* food, climate regulation, molecules for medicine). Around the globe, billions of individuals depend on the ocean and its biodiversity for their livelihoods, whether as a direct source of food, revenue, or both (fishing, harvesting of algaes, aquaculture).[151] Oceans and their ecosystems are also key to regulating the climate and mitigating the effects of climate change.

Yet, ocean biodiversity is in danger. According to the IPBES: "Almost a third of reef-forming corals, sharks and shark relatives and over a third of marine mammals are currently threatened.[152] The main drivers of this loss of ocean biodiversity are; [153, 154]

- **Overfishing and destructive fishing techniques,** mostly due to industrial fishing. In some places artisanal fishing can also be detrimental when there is poor resource management ;
- **The alteration and destruction of marine habitats**, which can be caused by fishing or deep sea exploration for oil, gas or minerals for example, **and of coastal habitats,** which are key for marine biodiversity (*e.g.* mangrove destruction for shrimp farming, conversion to aquaculture, coastal development);
- **Pollution** including for example plastic pollution (75-199 million tons of plastic are currently found in the ocean)[155] and chemical pollution from agricultural

[150] *Mora, C., Tittensor, D. P., Adl, S., Simpson, A. G., & Worm, B. (2011). How many species are there on Earth and in the ocean?. PLoS biology, 9(8), e1001127.*

[151] *See part I for a longer discussion of the importance of biodiversity, marine or terrestrial, for our livelihoods, economies and well-being.*

[152] *IPBES. (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. S. Díaz, J. Settele, E. S. Brondízio E.S., H. T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S. M. Subramanian, G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A. Pfaff, S. Polasky, A. Purvis, J. Razzaque, B. Reyers, R. Roy Chowdhury, Y. J. Shin, I. J. Visseren-Hamakers, K. J. Willis, and C. N. Zayas (eds.). IPBES secretariat, Bonn, Germany. 56 p.*

[153] *The relative order of magnitude may vary by region.*

[154] *See O'Hara, C. C., Frazier, M., & Halpern, B. S. (2021). At-risk marine biodiversity faces extensive, expanding, and intensifying human impacts. Science, 372(6537), 84-87. See also the IPBES 2019 report referenced above.*

[155] *See: United Nations Environment Programme. (2021). From Pollution to Solution: A global assessment of marine litter and plastic pollution. United Nations Environment Programme, Nairobi.*

and industrial sources (the leakage of agricultural fertilisers has created dead zones such as in the Mexican Gulf);[156]

- **Climate change** has an impact through **ocean acidification, deoxygenation, changes in currents and ocean warming**. Oceans are key for climate change mitigation, as they absorb a tremendous amount of carbon (30% of CO_2 emissions are absorbed by oceans[157]). There are however limits to the amount they can absorb. As these limits are being reached, this excess absorption leads to ocean acidification. This, together with the increase in ocean temperature, is highly detrimental to marine species. Additionally, the increase in the stratification of water masses due to climate change translates into lower primary production in surface waters, leading to lower fish catches;[158]
- **Maritime transportation,** which can impact ocean biodiversity through several channels: noise pollution, contribution to climate change, direct collision with marine animals, pollution of sea waters (*e.g.* hydrocarbons or other chemical leakages, antifouling paint biocides, plastics), ballast water discharge leading to invasive alien species introduction, other direct physical impacts (*e.g.* anchoring, abrasion, sediment disturbance by navigation in shallow waters).[159]

In our discussions with experts and NGOs, we identified several challenges, but also key levers, to limit further the erosion of marine biodiversity. Several of those ideas are aligned with what we have identified and described in other sections of this report (notably regarding education and professional training, the necessary changes in our consumption practices, the role of technological innovation that should not be overestimated and the importance of considering value chains to assess the biodiversity impacts of companies), but with some specificities related to the ocean topic.

Raising awareness and upskilling consumers, citizens, as well as members of governments, international institutions and companies is essential to address marine biodiversity depletion

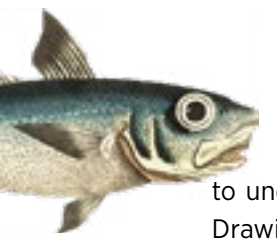
Terrestrial biodiversity and the levers to protect it may be more understandable and tangible for citizens and decision makers than in the case of oceans. Taking the example of agriculture, people can regularly see fields, crops, or machinery, first hand. When we eat or buy wheat, we can picture the fields it comes from, or the production process. Thus, we may understand the causality link, from nature and production to our consumption and the associated environmental impacts. For instance, if we decide to eat organic, we understand that less chemical products will be used on the field. Despite this; the increase of mobile applications such as Yuka or Eco-labelling for example proves the difficulty for consumers

[156] *NOAA. (2021). Larger-than-average Gulf of Mexico 'dead zone' measured: River discharge and nutrient loads contribute to size. NOAA. Retrieved from:: https://www.noaa.gov/news-release/larger-than-average-gulf-of-mexico-dead-zone-measured#:~:text=Today%2C%20NOAA%2Dsupported%20scientists%20announced,to%20fish%20and%20bottom%20species.*

[157] *NOAA. (2020). Ocean acidification. NOAA. Retrieved from: https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification#:~:text=The%20ocean%20absorbs%20about%2030,by%20the%20ocean%20also%20increases.*

[158] *The lower primary production in surface waters happens as cold nutrient-rich deep water masses mixes less with surface water (surface water is where primary production happens). See IPCC's special report on the ocean and cryosphere in a changing climate for more information on the impact of climate change.*

[159] *Abdulla, A. and Linden, O. (editors). (2008). Maritime traffic effects on biodiversity in the Mediterranean Sea: Review of impacts, priority areas and mitigation measures. IUCN Centre for Mediterranean Cooperation. 184 pp. https://portals.iucn.org/library/sites/library/files/documents/2008-042-1.pdf.*



to understand even terrestrial value chains. Drawing the link between consumption practices and marine ecosystems is even harder. Indeed, a large part of the ocean is hidden and unknown to most people, with life and resources lying beneath the surface, far from our sight. The world of fisheries, the fishing industry and the techniques and machinery used are usually poorly understood by the general public. The invisibility of ocean life makes it easier not to think about it, and to forget how dependent we are on it. Due to this more distant and more limited knowledge of ocean biodiversity and ecosystems, most people have a hard time understanding how their actions impact an ocean located sometimes thousands of miles out of sight, and consequently how to reduce their impacts. Hence, raising awareness about the ocean, marine ecosystems, their importance and the threats they face, is paramount to foster protection of marine biodiversity.

Raising consumer awareness on fisheries and fishing activities is also key. This may help citizens understand where the fish or shells they eat are coming from, how they were produced (farmed or harvested), as well as the environmental impact of this product along the production chain. BLOOM, an NGO working on marine conservation, has indicated that some labels (*e.g.* Marine Stewardship Council - MSC) do not always offer a sufficient guarantee of sustainable fishing practices.[160] Overfishing and destructive fishing techniques are a key driver of habitat destruction and biodiversity loss in the ocean.[161] Naturally, governments are key for protecting marine biodiversity from destructive fishing practices. The evolution of consumption patterns can also have a significant impact:

- Consumers should favour locally fished species, for which sustainable fishing practices were used (*e.g.* line or traps), and avoid as much as possible products from trawl fishing[162] that are destructive, and responsible for important unwanted, incidental by-catches (*e.g.* dolphins);
- Species from far away, and sourced in deep water, should also be avoided;
- Consumers should shift towards more sustainable fisheries and species such as small pelagic species (*e.g.* anchovies or herring), mussels or oysters;
- These consumption shifts should also be encouraged in public and private restaurants, canteens and catering services;
- More generally, we should reduce our individual consumption of fish, in order to not exceed the capacity of the ecosystem to sustain such a consumption level. The increase in consumption of fish and sea products in the past decades was notably supported by the claimed environmental and health benefits of fish vs. other sources of protein, which are not necessarily supported by scientific evidence.

[160] *BLOOM Association. (2020). Label MSC: La belle arnaque. Retrieved from: https://bloomassociation.org/msc-label-arnaque/ and Le Manach, F., Jacquet, J.L., Bailey, M., Jouanneau, C., Nouvian, C. (2020). Small is beautiful, but large is certified: A comparison between fisheries the Marine Stewardship Council (MSC) features in its promotional materials and MSC-certified fisheries. PLoS ONE 15(5): e0231073.*

[161] *IPBES (2019), Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages.*

[162] *Trawling is a fishing technique in which a net is being dragged in the water behind one or several boats.*

> **"We advise citizens and companies wishing to lower their impact on marine biodiversity to, on the one hand, consume less animal protein and shift toward more plant-based protein that have a lower environmental impact, and on the other hand, to source fish from line fishing/angling or trap fishing, which are less intensive fishing techniques, with a low environmental impact. "**
>
> Augustin Lafond,
> BLOOM

Beyond the issue of fishing, **awareness about ocean biodiversity and the threat it faces would help all stakeholders realise that many terrestrial activities heavily impact marine species and ecosystems:** use of chemicals and plastics, waste management, coastal development projects, pollution of terrestrial water systems, etc. This raises again the question of changing consumption habits and production processes to reduce our environmental footprint. Recycling alone will not be sufficient.

Companies should be proactive, even in the absence of regulation, and take up transformational changes

Almost every sector participates in negative externalities on the ocean along their value chain, directly or indirectly, but with different degrees of magnitude: through maritime transportation, GHG emissions, pollution, transport of invasive alien species by sea, sourcing of materials, use of resources (see the debate around rare materials), etc.

The continuation of business as usual with its impact on ecosystems is not compatible with biodiversity conservation. Technological innovation, alone, will not solve the problem. For example, technologies aiming at collecting plastics in the sea, while helpful, will not suffice, especially with a doubling of plastic production projected by 2050 according to UNEP.[163, 164] The core of the problem lies in the overproduction and under-recycling of plastic and other materials, and in the mismanagement of waste generation that leads to massive leakages in the environment. Additionally, such technologies can also lead to rebound effects (*i.e.* increase use / disposal of plastics).

Transformational and fundamental changes along value chains are needed to accompany the changes in consumption behaviour. One example that can be illustrative is the case of packaging, often pointed out as a driver of pollution, in particular plastic pollution. Companies may decide to simply change packaging (*e.g.* less plastic and more alternative "sustainable" materials), keeping their overall chain and process identical. However, reducing the overall packaging and opting for bulk or reusable containers wherever possible (*e.g.* food

[163] *UNEP (n.d.). Our planet is choking on plastic. Retrieved online from: https://www.unep.org/interactives/beat-plastic-pollution/*

[164] *Additionally, techniques aiming at collecting plastics at the surface do not deal with microplastics which can be present at different depths in the water. Microplastics are then ingested by marine species, and by humans eating sea products.*

industry and distribution) is essentially what is needed to lower the impact on biodiversity and the environment more largely. Experts pointed out that mass distribution was a key pillar of this transition, and can drive significant advances. **Companies should be proactive** in engaging in this transition and in transforming their processes and supply chains, **even in the absence of regulation.**

Companies are still ill-equipped to tackle the causes of the destruction of marine ecosystems. Such transformation requires a specific and dedicated workforce, trained for the task (with a scientific culture and technical competences related to biodiversity and the environmental impact of activities, and an understanding of the regulatory framework and its evolutions). Such a background is key to understand the negative impact of human activities on biodiversity and to identify effective measures to mitigate it. All companies, in particular smaller ones, may not be able to develop this required knowledge, hence the need to help them at the sectoral and local levels (as indicated in other parts of this report).

Ocean protection calls for a clarified governance

While proactivity on the side of companies and consumers is highly recommended, a clear governance framework at the international level and regulation remain a major catalyst for change, for several reasons:

- **Marine species are not confined** to a specific location but rather migrate every year across territorial boundaries.
- **Marine pollution is often diffuse,** and while it may originate from a specific point, it can spread over a large distance in the ocean.
- **Deep ocean and high seas areas do not belong to anyone** and are not located within the territorial boundaries of one country (*e.g.* within economic exclusive zones, under national jurisdictions). These areas are often considered as "global commons" which can suffer from what Hardin described as "the tragedy of the commons": an overconsumption of resources and an underinvestment in the preservation of these environments which ultimately leads to their depletion.[165] The absence of strict regulation, property rights or a governance framework over the shared resource are responsible for this depletion. This phenomenon has already led to permanent collapses of fish populations in certain fisheries due to overfishing and the destruction of habitats.

Several of our interviewees stressed the need for a **strong international regulatory framework,** accompanied by policies and planification at the national and local level, and with control and strong enforcement of existing and new regulations, which is not always the case today.

Governmental but also private action should also **support research and development of new tools and databases to enable integrated ecosystem approaches**. Data collection and development are currently organised by sector. This siloed knowledge needs to be shared and **the links between them underlined notably to enable each actor to understand how they contribute to the degradation of marine ecosystems**. Public-private partnerships for research for the protection of marine biodiversity have already been developed.

[165] *Hardin, G. (1968). The Tragedy of the Commons: The population problem has no technical solutions; it requires a fundamental extension in morality. Science, 162:3859,p.1243-1248.*

For instance in France, the SNCM (Société Nationale maritime Corse-Méditerranée) has worked with an NGO (Miraceti) and researchers to develop an application, Repcet, to monitor whales' movements and avoid collisions with their ships.[166]

The case of marine biodiversity only illustrates more strongly governance challenges that are pervasive across environmental issues and need to be dealt with to ensure the global, integrated protection of biodiversity.

KEY LEARNINGS:

- Protecting the ocean and marine biodiversity is of paramount importance, as it provides key ecosystem services (*e.g.* food, molecules for medicine), but it is danger due to an-thropogenic pressures (***e.g.*** pollution, overfishing, habitat destruction, climate change);
- Raising awareness and providing training about marine biodiversity and ecosystems among consumers, citizens, as well as members of governments, international institutions and companies is essential to address ocean biodiversity depletion;
- Considering that overfishing and destructive fishing techniques are a key driver of habitat destruction and biodiversity loss in the ocean, actions from governments and changes in consumption patterns could have a significant impact to decrease pressure;
- Companies should be proactive, even in the absence of regulation, and take up transformational and fundamental changes along their value chains;
- Ocean protection calls for a clarified and strong governance.

4.5. The financial sector is a necessary bedrock for the transition

The financial sector is central to address the climate and biodiversity challenges

The commitment of the financial sector is critical in the transition to a more sustainable economy, as has been highlighted over the past few years in the case of climate change. This is also true for biodiversity.

Finance performs several roles, which can be presented along the following lines;[167]

- Production of information about possible investments / projects, and allocation of capital;
- Monitoring of investments and corporate governance after the deployment of capital;
- Facilitation of trading, diversification, and management of risk;
- Mobilisation of savings;

[166] *Breuneval, F. (2022). Le transport maritime s'associe aux chercheurs pour venir au secours des océans. Novethic. Retrieved from: https://www.novethic.fr/actualite/economie/isr-rse/le-transport-maritime-s-associe-aux-chercheurs-pour-venir-au-secours-des-oceans-150752.html.*

[167] *Levine, R. (2005). Finance and growth: theory and evidence. Handbook of economic growth, 1, 865-934. https://doi.org/10.1016/S1574-0684(05)01012-9.*

- Facilitation of the exchange of goods and services.

To these roles, we may add the insurance and reinsurance of risk - notably to the extent that this risk is not specifically related to an investment or provision of lending.

In each of these functions, environmental, and in particular biodiversity considerations, come into play. By way of example, the financial sector is central to:

- The definition of environmental and biodiversity information, obviously relying on data coming from companies;
- The inclusion of biodiversity criteria in the analysis of projects and investments;
- The monitoring of risk run by companies as a consequence of their dependency and impact on ecosystems;
- The channelling of savings towards more sustainable investments.

Very concretely, the financial sector can impact the behaviour of companies through:

- The availability of capital, by committing to exit from the financing of activities with a significant impact on biodiversity (either directly or through climate change);
- The cost of capital, i.e. increasing the financing costs of companies harming biodiversity and decreasing that of more virtuous firms in order to align capital flows with a sustainable state of the world;
- The insurability of activities with a significant impact on biodiversity, and its cost.

A significant part of this action goes through the plans of the financial sector to cope with climate change, given the major contribution of climate change to biodiversity erosion. However, financial institutions need to take into account biodiversity as well, to deal with the other four drivers of pressure of human activity on ecosystems:

- Change in land and sea use;
- Direct exploitation of certain organisms;
- Pollution;
- Invasive alien species.

Accelerating the transition is in the interest of the sector

Finance can, and should, take a long-term view on the profound transformation that our economies and business models need to undergo to face climate change and biodiversity erosion. The risks of the economy as a whole translate into risks for the financial system. Consequently, it is in its interest to anticipate, accompany, and accelerate the transition to a more sustainable economy.

This is a debate with deep ramifications far beyond biodiversity, encompassing the so-called environmental, social and governance (ESG) considerations in the financial sector and in capital markets. The underlying discussions usually fall in two broad categories which are often referred to as “ESG as an input” and “ESG as an output”.

- ESG as an input means that investors incorporate ESG factors that are financially material into their investment decision process. This can include for instance comparing the exposure to risks related to biodiversity among the set of possible investment projects;
- ESG as an output means that investors will make investment decisions with the explicit aim of improving specific sustainability outcomes. For instance, when choosing among two companies to invest in, an asset manager might choose to invest in the one

that is less profitable but contributes to the restoration of biodiversity.

While there are strong arguments to support that sustainable companies are set to perform better financially, certain sustainability issues are likely to have a negative impact on their profitability - typically, the emergence of stranded assets - requiring both capital and deep managerial involvement

It is worthwhile listing some of the reasons why the sector should be increasingly aware and concerned with biodiversity, in addition to ethics:

- **Valuation and opportunities:** companies and projects aligned with biodiversity objectives are likely to emerge more robust, and as a consequence, more valuable. To the contrary, companies unable to anticipate environmental challenges at large are exposed to an accelerated risk of loss of value;
- **Risk:** the sector structurally bears several long-dated risks: this is notably the case for banks' and insurers' balance sheets. Consequently, it has an incentive to anticipate the transformation, in order to ensure the creditworthiness of its counterparts;
- **Regulation:** several public institutions and regulators have demonstrated their eagerness to be at the forefront of the GHG reduction battle, and have imposed structural regulatory changes, which had to be implemented over a short timespan. This is for instance true at the European level, with the issue of the EU Commission's Action Plan on Financing Sustainable Growth, and the significant stream of regulation which ensued (SFDR, EU Taxonomy, etc.).[168] The creation of the Central Banks and Supervisors Network for Greening the Financial System (NGFS) is also a strong signal sent by regulators and supervisors of the attention paid to the role of the financial system in supporting the transition.[169] Given the urgency to tackle the loss of biodiversity, similar regulation could be expected, with a premium to financial players able to anticipate such changes;
- **Client demand:** the increasing attention of clients to environmental issues is an important driver of change in the financial sector;
- **Reputation:** similarly, financial institutions are under heightened scrutiny from regulators, NGOs, and the general public;
- **Employee value proposition:** the environmental and biodiversity commitments and actions displayed by all companies - notably financial institutions - are a significant factor of attractivity for the best talents.

Several of our interviewees highlighted that the awareness of biodiversity in the financial sector is both heterogeneous and in the making.

The concept of an orderly transition is of particular relevance to the financial sector, which reflects the state of the economy at a particular point in time

By construction, the exposure of the financial sector is a reflection of the composition of the economy at a certain point in time. This is true of biodiversity impact as it is of GHG

[168] *European Commission Directorate-General for Financial Stability, Financial Services and Capital Markets Union. (2018). Renewed sustainable finance strategy and implementation of the action plan on financing sustainable growth. Retrieved from: https://ec.europa.eu/info/publications/sustainable-finance-renewed-strategy_en.*

[169] *https://www.ngfs.net/en.*

emissions. A profound change in the structure of this exposure takes time: for instance, a 10-year loan granted by a bank will stay on its balance sheet for a number of years - and even if sold or syndicated, the features of the underlying company or project will remain part of the financial sector for the term of this loan.

Hence the importance of anticipation, decisive action, and planning of the sector as a whole. A balance sheet changes slowly, as older exposures mature and new ones enter the balance sheet. A forward-looking approach is therefore warranted, to ensure that new exposures gradually reflect the economy as it should be tomorrow.

Schematically, the orderly transition of the sector's exposure will consist of:

- Exiting certain activities, companies or sub-sectors: this tends to be applicable to the most detrimental activities, the financing of which needs to be curbed quickly (*e.g.*, deforestation in the most fragile ecosystems);
- Accompanying the transformation of many sectors, which will need to be incentivised and supporting during the transition;
- Funding the projects - for instance infrastructure - necessary to support the transition, and to mitigate its impact;
- Financing innovations contributing to the transformation.

It is important to underline that the financing of innovative - including, but not limited to, technology - companies is neither the only, nor likely to be the main, component of this transition. The transformation of the economy will hence require engagement with companies, monitoring of their progress, and significant investments and costs to corporates, the financial sector and public institutions (most of which are also major stakeholders in financial markets).

Efforts to develop disclosure are critical, even if they do not lead to a single biodiversity metric

The multidimensional and local nature of biodiversity poses a challenge to the emergence of a single aggregated metric (as discussed in part 3.2). This is not an impediment per se, as financial institutions are accustomed to analysing risks and flows taking into account several dimensions of a project. However, the difficulty in creating a single metric will mean that (i) more time will be needed to factor biodiversity considerations into credit / insurance decisions, and that (ii) the inclusion of biodiversity in the common vocabulary of financial markets will be more challenging.

One of the main issues that financial institutions encounter is the lack of reliable biodiversity data for most companies. There are several layers to this issue:

- While some large groups are developing biodiversity metrics, most companies have not yet done this work;
- This data (even if not aggregated) is not harmonised within each sector, let alone across sectors;
- The quality of the existing data is not homogenous, and rarely audited.

As a consequence, efforts to improve and harmonise corporate disclosure of biodiversity data should be encouraged and accelerated.

Financial institutions and corporations are moving in a quickly evolving regulatory context with many consultations and legislative changes in the main financial centres. France sits at the forefront in this view: since the 2015 energy transition law institutional investors have been

required to disclose the environmental aspects of their activities - through the well-known "article 173" - which has been reinforced in 2021 to incorporate the latest European regulation and the addition of a specific focus on biodiversity (art. 29 of the Energy and Climate Law).

Market and stakeholder-based solutions can provide at least a partial answer to the regulatory and standardisation gap. This is best illustrated through the development of the Taskforce on Nature-related Financial Disclosures (TNFD), which was initially developed in 2021 by market participants, relies on the support from various scientific bodies and has been endorsed by governments and multilateral bodies. In parallel, initiatives from financial centres will be pivotal for market participants to exchange views on standardisation prospects and best practices. Their relevance is reinforced by the presence of representatives of regulators and supervisors in working groups to gather feedback on potential regulatory changes and thus ensure timely and smooth implementation afterwards.

> **"I see the SBTN and the TNFD arriving as tsunamis for biodiversity, similarly to what happened with climate a few years ago"**
>
> **Julia Maris,**
> VP Corporate and Social Responsibility, ENGIE

It follows the successful model of the similar Taskforce on Climate-related Financial Disclosures, created in 2015. However, **it should be noted that such initiatives cannot be a long-term replacement for meaningful policy and regulatory changes which will be required to incentivize the financial system in the right direction.** Regulation is also paramount to the credibility of the financial system on its journey, as it limits the risk of greenwashing, which would be detrimental to the efforts of the industry.

The risks posed by biodiversity are structurally difficult to take into account for the financial sector

We lack precedents which are key to the creation and testing of risk models: as the current biodiversity loss is unprecedented, and its impact on the companies was rarely measured, the modelling of biodiversity risks' impact on companies is still in the making, and will need time to be calibrated.

Another important issue is the form of the risks. The financial sector has a reasonably strong understanding of the distribution curve of risk of various natures: for instance, the typical distribution of car accidents and their severity is well known by insurance companies, and banks know how to comprehend default risk on various types of loans. The nature of biodiversity risks create a strong uncertainty in their potential frequency, magnitude and impact. The interactions with climate risk amplify this problem.

This is another major reason to act as much as possible to prevent the occurence of biodiversity cliffs rather than to focus on mitigating their effects, as the consequences of this occurrence are particularly hard to fathom.

Several experts have pointed out to the need for more investable projects supporting biodiversity

As awareness of the importance of biodiversity is still gaining traction, the number of projects both being accretive to biodiversity and being investable appears to be still limited. This is not necessarily surprising, as it does take time to

identify the projects, as well as the key features required to render them investible.

This reinforces the need for further dialogue between biodiversity experts, corporates, and the financial community to determine the key criteria (size, yield, geographical focus, etc.) to expand the pool of investable projects and bring them to scale.

Acknowledging the limitations to the current understanding of the matter

These various factors plead for humility as to the existence of data and tools to tackle the issue entirely.

It also calls for a pragmatic approach, in which action is taken on the basis of partial, and imperfect information, accompanied with regular assessments allowing to improve data and tools.

Training and upskilling of staff is critical for the financial sector

The financial sector is largely driven by the knowledge and skills of its employees. As has been indicated, the inclusion of biodiversity - and environmental - criteria in financial decisions requires new and increasingly sophisticated skills.

As in the corporate sector, there is a significant need for training and upskilling of the staff in the financial sector. Hiring specialists with a scientific background will also be needed to accompany banks, insurers and investors in their analysis of environmental impacts, dependencies, and risks.

The required transition of banks

Banks will need to play a key role in factoring biodiversity targets in financing - notably credit decisions. This role is underpinned by the local implantation of banks and their ability to finance projects at all scales as required by the specific challenges pertaining to biodiversity.

Universal banks can have hundreds of thousands of outstanding loans, notably to individuals and small to midsize companies. A key takeaway from discussions with interviewees is that the multiplicity of drivers of biodiversity loss combined with the size of loan portfolios suggests that banks might need several years to assess their exposure to biodiversity risk for each and every loan.

Due to the variety of financed projects, banks are an important illustration of the need to refrain from sticking to a unique biodiversity indicator, as a loan for a water sanitation project and a loan for a railway will not necessarily impact the same drivers of biodiversity loss.

We note that the proximity of banks with their corporate clients, through long-lasting relationships, makes them well positioned partners to engage with companies on biodiversity issues, triggering a recognition among executives and then accompanying them throughout the transition by designing adequate financial products.

These long-standing relationships could pave the way for financial innovation in the field of biodiversity with instruments designed for the idiosyncratic needs of every client. An example is the "payment for environmental services" that is being developed with specific corporations who happen to rely for their core business on biodiversity (see part 1 for a short discussion on payment for environmental services).

In essence, banks could pave the way by:

- Mapping their customers (primarily corporate ones) according to biodiversity criteria;
- Presenting an ambitious plan to exit the funding of the most detrimental activities. A parallel can be drawn with the exit of coal financing in the fight against climate change;

- Actively engaging with clients to raise awareness of biodiversity issues, their measurement, and trigger decisive action to mitigate their biodiversity impact;
- Funding actions positively protecting biodiversity, with a focus on the most degraded and important ecosystems;
- Developing new products to finance the needs of the transition, notably in the agrifood sector;
- Funding innovative solutions supporting the transition.

The required transition of investors

Investors are among the most advanced stakeholders in their understanding of environmental issues, driven both by increasing demands from asset owners and increasing regulatory scrutiny, *e.g.* the development of environmental taxonomies of economic activities.[170]

Biodiversity is conceptually identified as a key topic; nevertheless, its understanding and inclusion in investment decisions is still clearly lagging behind that of GHG emissions.

There are several approaches for investors to integrate biodiversity - as with any ESG matter - which can be categorised as follows:

- **Exclusions:** excluding certain companies or sub sectors from the investable universe;
- **ESG inclusion:** inclusion of non-financial considerations in the investment process. This can include separate targets for non-financial metrics (*e.g.* over performance vs benchmark);
- **Best-in-class investing:** positive practices designed to improve companies' non-financial performance;
- **Thematic investing:** investing in environmental macro-trends that drive capital allocation to specific companies or segments;
- **Impact investing:** investing in companies and projects aiming at a precise and measurable positive impact on non-financial metrics.

In addition, several investors underline the importance of engagement or stewardship, which encompasses a demanding dialogue with companies and a voting policy clearly supporting environmental and biodiversity action.

These approaches have advantages and drawbacks, and they are not mutually exclusive. Their relevance will usually depend on the underlying biodiversity issue, and also on the investment universe which can put additional constraints as regards portfolio construction.

Interviewees stressed that awareness has been rising recently, linking that to the boom around climate change observed in the investment community in 2015, with the COP21 or Mark Carney's landmark "tragedy of the horizon" speech. Many investors had presented their climate strategy around the COP21, building on the political and public opinion momentum, and biodiversity strategies have started to be presented recently.

[170] *See for example the development of the EU green taxonomy of economic activities.*

Biodiversity strategies are however not yet transverse and are clearly less advanced in their sophistication and implementation than climate strategies. The momentum around biodiversity is growing at top management level, at least in Europe. We can expect that investment strategies among investors will improve in the coming years due to (i) better indicators and data quality, (ii) improved corporate reporting standards, (iii) the generalisation of best practices among investors, and (iv) more demanding regulation.

On the other hand, in many countries the regulation regarding biodiversity remains focused on the "input" aspect, i.e. focusing on the risks associated with biodiversity and preventing such issues from getting in the way of profitability. The US have been mentioned as an example, with the "ERISA" legislation which forces investors to base their strategies solely on risk-return factors.

Investors stress the inherent difficulty of finding the right scale of analysis for biodiversity factors which often require a local, project level analysis which might be incompatible with many investment methods such as passive investing or macro strategies.[171] Most investors lack the human power to conduct such analysis. The complexity of it is sometimes not compatible with the timing of investment decisions. This relates to the aforementioned debate about the coexistence of several levels of biodiversity indicators depending on the exact situation.

Additionally, the rise of passive investing over the past decades calls for a specific attention to be paid in this area. Indeed, a small change in the construction of indices and the weights of various components can result in the shift of billions of dollars towards more responsible securities and impinge upon the financing costs of enterprises which are not engaging in the transition.

It is worth mentioning that the focus tends to be more on listed companies which only represent a portion of the economy. Unlisted companies, who get funding from banks and investors closer to the founders, are of high significance to the transition and should be onboarded.

As the solutions to the biodiversity crisis can in essence be local and more decentralised than these to the climate crisis, it will be essential to bridge this gap in size between the main liquidity pockets among institutional investors and "on the ground" initiatives with idiosyncratic risk profiles.

It seems like an interesting option is to implement derisking mechanisms through public institutions such as multilateral and regional development banks which would mobilise their balance sheets to extend guarantees and spur private capital flows. This development of blended finance[172] has been ongoing in recent years, *e.g.* for the development of infrastructures in Africa, and we can benefit from such experience in the design of specific financial solutions related to biodiversity. However, the development of blended finance is hindered by several structural factors, including:

- The very small size of projects, which make their identification, assessment and monitoring difficult;

[171] *Passive investing is an investment strategy through which investors reproduce an index defined by a provider, as opposed to active stock-picking. Macro strategies instead look at broader asset classes and important macro-economic and political movements, instead of focusing on the instrument-level fundamental analysis.*

[172] *Blended finance initiatives combine public and private financing for specific purposes. The presence of public funding can help attract outside investors, and is often combined with a "de-risking" approach whereby public actors offset part of the risk for private investors, leveraging private capital flows for risky yet necessary investments.*

- The idiosyncrasies of each project, which slows the deployment of capital across numerous projects;
- The need to have teams on the ground to analyse and monitor the projects, notably in regions with a more complex local environment;
- The complexity of dealing with more stringent risk and compliance regulations and policies, while several of the countries in which the projects are located provide limited guarantees on this front.

Insurers and reinsurers need to better comprehend and take into account biodiversity risk

Insurers and reinsurers ("insurers" hereafter for clarity purposes) stand to be especially exposed to the collapse of biodiversity and its physical impacts. The exposure will specifically materialise on both sides of their balance sheet: biodiversity risk will be felt on the asset side by lowering the value of some assets and investments, while the biodiversity loss will generate events triggering more insurance policies and requiring recurring disbursements on the liability side. As a result insurers are already focusing on strategies to adapt to risks related to biodiversity, and are willing to play a role to mitigate the impacts and whenever possible avoid the crisis.

Insurance strikes as an illustration of an industry which, faced with the impacts of the twin biodiversity and climate crises could see a sudden change in their economic model. On the one hand the heightened frequency of extreme events such as natural catastrophes or zoonose-induced pandemics - both likely in business as usual scenarios - would cause recurring shocks to insurers' balance sheets, depleting their buffers at an increasing pace.

> **"It is necessary to better share transition risks across value chains. It is the responsibility of insurers to take up part of the increased exposure to climate risks incurred by farmers who reduce their use of pesticides."**
>
> **Antoine Denoix**,
> AXA Climate

We note from discussions with executives from the sector that, on the other hand, insurance is an especially efficient sector when it comes to supporting the transition. As opposed to investors acting on the cost of capital, conditions associated with subscription to an insurance directly impact the profits and losses. Insurers can even prevent companies from pursuing the project altogether, by using an exclusion approach.

However, exclusion for insurers as well as investors remains difficult in a globalised financial system. Without a worldwide consensus, the choice of certain insurers to deny insurance to certain activities would only have a limited effect if the companies at stake are able to get coverage from other financial centres with a less drastic approach and regulation.

Thus insurers, like investors, in the absence of global regulation and consensus , have to walk a fine line between the willingness to decrease business with companies engaging in activities which accelerate the biodiversity crisis, and the knowledge that letting them turn to less environmentally committed insurers could lead to worse outcomes.

Additionally, insurers are also among the biggest investors globally, and hence face all the challenges listed above. However, it is worth noting that due to their involvement in analysis business and environmental risk as part of the core business, insurers in their investor role seem well placed to tackle long-term challenges such as the biodiversity crisis.

Credit rating agencies

Finally, credit rating agencies (CRAs) can play a significant role. Following the 2008 Global Financial Crisis and the criticism that CRAs have faced, regulators and supervisors implemented regulatory reforms increasing the transparency and standardisation of rating methodologies.

CRAs can only incorporate in their analysis the sole factors that are material to default risk. In theory, all else equal, CRAs will improve the rating of a company affecting biodiversity while in the process increasing its profitability. A fine line for them to walk as regards ESG issues, the materiality of which is still sometimes debated depending on the time horizon.

The main CRAs are gradually improving their understanding of ESG issues, including biodiversity, and modifying their methodologies accordingly. While the S and G pillars are rather well understood by CRAs, it remains quite rare for environmental factors to be the main drivers of rating actions - extreme weather events being the main outlier in this view, including drought which can for instance severely impact the external position of agricultural commodities exporters.

Contribution to the drivers of biodiversity loss and exposure to risks still has little impact on ratings, although many are already material for many issuers, such as water stress or even broadly speaking the COVID-19 pandemic and such "Green Swans"[173] or tail risks which could become more frequent and severe as the erosion of biodiversity accelerates (see box on pandemics in part I). One of our interviewees also stressed the exposure of some companies (notably petrochemicals companies) to what he called "biodiversity stranded assets", the equivalent for climate of sectors that are of high risks, either systemic, transition, or physical risks (see part I for definition).

Most CRAs have developed a separate business division to provide ESG data to clients without facing the same regulatory oversight. They are in direct competition with a flurry of older and new players in this field which is growing significantly on the back of increased demand by corporates and market participants for ESG data, especially when it comes to biodiversity.

The efficiency of the use of data for investment strategies and financing decisions will come as explained above, through increased standardisation.

[173] *"Potentially extremely financially disruptive events that could be behind the next systemic financial crisis" as defined in: Bolton, P., Despress, M., da Silva, L. A. P., Samama, F., & Svartzman, R. (2020). The Green Swan—Central Banking and Financial Stability in the age of climate change. Bank for International Settlement.*

KEY LEARNINGS:

- The financial sector, in its entirety, needs to mobilise itself for the protection of biodiversity;
- As the risks it bears are a reflection of the risks to the economy, it is in its interest to accompany a decisive and orderly transformation of the economy;
- Efforts to improve disclosure are important, even if they do not lead to a single aggregated metric;
- The various financial stakeholders can impact very different compartments of the economy (SMEs, large corporations, listed companies, infrastructure projects, etc.);
- Regulatory intervention may be required to improve and possibly harmonise disclosure, ensure the credibility of the transition, and provide the right incentives to companies and financial institutions.

Box 6

The point of view of Eric Lombard (H 81), CEO of the French Caisse des Dépôts

1/ Why should we take action to preserve biodiversity now, more than ever?

For too long, biodiversity has been treated as a "second-rate" urgency when it comes to protecting our planet, with a stronger focus on reducing carbon emissions and climate change. But if we intend to successfully achieve the transition towards a sustainable economy, we must tackle both issues with the same level of commitment. I am glad to see that awareness has increased in the recent years, with a growing number of economic actors taking measures to reduce their impact on nature. In September 2020 a few months before COP 15, Caisse des Dépôts signed the Finance for Biodiversity pledge alongside 25 financial institutions. A year and a half later, 89 institutions in over 19 countries have joined the initiative.

The challenge we are facing is no small feat, precisely because economic development as we have conceived it up to now, leads to "consuming" increasing amounts of ground space to accommodate our needs for housing, industry, energy production... But we know that there can be no healthy business, resilient economies and long-term value creation without nature conservation. I am convinced that we have the means to bring about innovative solutions to allow for continuous development, while protecting biodiversity. Such solutions will require massive investments from public and private investors, that can only be achieved if investors and shareholders accept to reduce the cost of capital and thus the expected return on investment. And if we collectively rise up to the task, protecting biodiversity – like fighting against climate change – can be a long-term driver for economic growth and jobs.

2/ As a long-term investor, how can Caisse des Dépôts contribute to raising awareness and reducing our impact?

The first step towards reducing our impact is to measure. In the fight against climate change, the development of measuring tools for carbon emissions was a game-changer, in terms of awareness and of positive action. We must have a similar approach when it comes to biodiversity. In May 2020, our subsidiary CDC Biodiversité created the Global Biodiversity Score (GBS): this tool provides companies and financial institutions with shared and sound metrics to assess their biodiversity footprint.

Caisse des Dépôts holds over €225bn of assets under management, mainly in France or in Europe. As such, we have the leverage – and the responsibility – to accompany many companies in steering their strategy on a more sustainable path, including the protection of biodiversity. Caisse des Dépôts aims to produce a full-scale assessment of the biodiversity footprint of all its portfolios by 2024. In the meantime, we have already reinforced our action to challenge our portfolio companies through continuous and rigorous dialogue, and encourage them to adopt action plans for diversity. This work has already started with companies from the agribusiness and chemical sectors and 2 new sectors will be targeted each year.

3/ Caisse des Dépôts is a public investor, financing many projects alongside the French public local sector. How can you assist them in developing more projects to preserve and protect biodiversity?

Financing positive solutions for biodiversity is the second leg of our strategy. Since its creation in 2008, CDC Biodiversité has been active in promoting offset projects to restore ecosystems. Through its "Banque des Territoires", Caisse des Dépôts is allocating over €3bn between 2020 and 2024, to finance local projects focused on restoring and protecting nature, depolluting water and improving waste treatment and recycling. This includes solutions to fight against land artificialisation, notably by rehabilitating industrial and urban wasteland, as in Creil (Northern France), where Caisse des Dépôts is financing a project led by Photosol, to transform a former airbase into one of the largest solar power plants in Europe. Protecting biodiversity also means acting to mitigate the effects of climate change, and we plan to dedicate over €60bn to the environmental transition between 2020 and 2024.

As a public long-term investor and as a Group of over 16 subsidiaries active in many fields of economic development (housing & construction, energy, tourism...) is fully mobilised to help achieve the transition towards a sustainable economy, in all our areas of expertise !

5. BEYOND BUSINESS: BUILDING MOMENTUM WITH CONSUMERS, CIVIL SOCIETY, POLICY MAKERS AND NGOS

5.1. Civil society must be involved, notably through its consumption patterns...

Throughout our discussions with interviewees, a common theme was the need for the involvement of civil society to initiate and support the transition as consumers. Indeed part of the inertia is due to businesses sticking to clients' not yet evolving demands.

Consumption can also be thought of as a form of power for every citizen, which needs to frame its day-to-day purchases as choices related to the biodiversity crisis among other considerations.

For years, western society has established a definition of success based on specific consumption habits with significant negative impacts on biodiversity and climate change, such as distant travels for very short time periods, the access to a wide variety of goods in large supermarkets far away from city centres, the consumption of unsustainable goods with high environmental impacts, etc. It will be a difficult endeavour to change the model that people have been pursuing for several generations.

Thus it will be vital for policymakers to take a transparent and fair approach, which could rely on clear, quantitative metrics to show that everyone's contribution is in line with agreed upon policy objectives and that the transition is not made at the expense of specific parts of the population. Such metrics would in turn help people make informed choices in their everyday life, and avoid focusing on secondary issues.

Overall, the topic of "frugality" emerged in discussion with most interviewees, with a message: the changing our consumption habits was a necessity to preserving, and restoring biodiversity.

5.2. ... Like policymakers

Although we can rely to some extent on economic incentives to change people and businesses behaviours, the role of policymakers will be key in ensuring an orderly transition and avoiding any free-riding.

In the short term, policymakers need to improve the dialogue among stakeholders by building or supporting forums to promote exchanges. It can build on existing initiatives which are already gathering momentum such as One Planet Business for Biodiversity.

In this view, policymakers can also help streamline this dialogue and coordinate initiatives, the multiplicity of which can hamper readability and accountability.

"It should be mandatory for all companies to assess and disclose impacts and dependencies on nature for their direct operations and value chain."

Renata Pollini,
Head of Nature, Holcim

"Financial means to preserve biodiversity will come in particular from the redirection of adverse subsidies (ex: on fossil fuels, intensive fishing, building) to policies more advantageous for biodiversity and should not increase tax burdens on citizens."

Christian Hosy,
Coordinateur du réseau Biodiversité, France Nature Environnement

The organisation of the policy dialogue could be slightly different than the one for climate change. We understand from discussions with experts that it would be important to combine an overall monitoring structure with scientific expertise to keep a macro view, but that the action plans should be designed within sectoral coalitions leveraging their specific expertise to design adequate solutions focusing on the most material drivers and biodiversity loss hotspots for the field.

Local policymaking will be key, at the scale of cities, councils etc. This narrative has been emerging also with regards to climate change in recent years, so existing governance models at all scales could be leveraged in the fight against the biodiversity crisis. Governance will be key for local territories to develop global resilience strategies addressing the combined socio-economic and environmental challenges.

Finally, biodiversity will need to be included across the policymaking spectrum, starting from the budgetary process. Several interviewees stressed that aligning subsidies with biodiversity objectives, while designing fiscal incentives for nature-based solutions, was key. In this view, more innovation will be required in the absence of a unique metric

Beyond public expenditures, biodiversity is set to become key in policy design, especially in fields such as research, education, corporate and accounting standards, or financial regulation.

5.3. To succeed, the international governance should involve emerging economies

Finally, the impact of policy response will be considerably limited if it is not implemented across all countries in a coordinated manner, calling for a renewed push to achieve a multilateral consensus on the most important biodiversity-related challenges.

Coalition of like-minded stakeholders, be they public or private, will be key in advancing concrete initiatives which often span wide geographical areas, *e.g.* fishing and migrations across the oceans. Coalitions of private actors can also act as a trigger for policy changes by exerting pressure on public bodies on topics such as soybean imports or palm oil (*e.g.*, Roundtable on Sustainable Palm Oil).

While biodiversity and climate need to be addressed in parallel, there is a debate around the articulation of the bodies in which discussions happen. It was highlighted that merging the multilateral forums and institutions may be counterproductive, as it may give lower priority to certain topics vs. others.

As mentioned when it came to public awareness, this in no way precludes collaborations between multilateral bodies tackling the twin environmental crises. This could come through an articulation of the Nationally Determined Contributions and the National Biodiversity Strategies and Action Plans, to ensure that governments have a coherent approach for these two existential threats.

The need for separate multilateral negotiation tracks dedicated to biodiversity also stems from its local idiosyncrasies, which make high-level negotiations more difficult given the need to combine global considerations with some very local ones.

Additionally, some interviewees underlined the need to involve the key ministries in the preparation of negotiations, including the ministry of the economy or finance.

There is a debate on what objectives should propel biodiversity negotiations: while the Aichi Biodiversity Targets can be more precise and comprehensive, several experts told us that they would be in favour of using the framework of the UN's Sustainable Development Goals which are more widely known and to a large extent encompass the main drivers of biodiversity loss.

Additionally, we note that biodiversity negotiations often pertain to natural resources which are a matter of national sovereignty. This underpins the political or philosophical nature of biodiversity challenges, which most of the time prevent governments from accepting any binding commitment.

Although the biodiversity crisis is a global challenge, it is cardinal to keep in mind the extent of global inequalities and development when designing solutions to tackle it. Countries in the Global South are often the most exposed to the consequences of the biodiversity collapse. Furthermore, their populations heavily rely on healthy ecosystems for their livelihoods, yet they have huge development financing needs and a complete lack of fiscal space.

Biodiversity adds a layer of complexity, as many experts stress that it remains capital to group countries according to environmental variations, *e.g.* desert vs forests, instead of simply broad income groups. These environmental variations are obviously also observable within countries, making any classification inherently imperfect.

Finally, the question of how to effect and finance the transition in emerging markets and developing economies ("EMDEs") remains a challenging issue, with economic, social, environmental, and ethical ramifications, which are beyond the scope of this report. However, given the importance of biodiversity to EMDEs, and the location of some of the most prolific biodiversity hotspots in EMDEs, onboarding these countries is of critical importance to prevent the biodiversity crisis.

"Ecological accounting allows biodiversity to exist per se, as its own entity, with whom the economic sector can make transactions (and contract a debt). Working on corporate accounts allows to open up the discussion on business models. Hence, the extra-financial reporting and ecological accounting approaches are complementary."

Harold Levrel,
Researcher in Ecological Economics, CIRED. Co-director, Ecological Accounting Chair, Professor, AgroParisTech and Paris-Saclay University

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WWF (2020) *Living Planet Report 2020 - Bending the curve of biodiversity loss.* Almond, R.E.A., Grooten M. and Petersen, T. (Eds). WWF, Gland, Switzerland. https://www.wwf.fr/sites/default/files/doc-2020-09/20200910_Rapport_Living-Planet-Report-2020_ENGLISH_WWF-min.pdf

WEF and PwC. (2020), *Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy*, New Nature Economy series, https://www3.weforum.org/docs/WEF_New_Nature_Economy_Report_2020.pdf

COMPLEMENTARY RESOURCES

This list contains additional resources we have found interesting for those who would like to further explore the topic of biodiversity erosion. This list is of course not exhaustive.

Reports, studies and research article

Dasgupta, P. (2021), *The Economics of Biodiversity: The Dasgupta Review*. Abridged Version. (London: HM Treasury), https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review

Why read it? *This report explores and explains the economics of biodiversity, the reliance of our economies on biodiversity, and the importance of considering and including nature in economics.*

Deprez, A. *et al.* (2021). *Aligning high climate and biodiversity ambitions in 2021 and beyond: why, what, and how?* IDDRI, Study N°05/21.

Why read it? *This great analysis questions the siloed reasoning around climate and biodiversity, and the disastrous impacts it could have on the achievement of global international targets not bridging the gap between the two crises.*

EPE. (2020). *Solutions des entreprises pour la biodiversité: changer d'échelle*. http://www.epe-asso.org/solutions-des-entreprises-pour-la-biodiversite-changer-dechelle-octobre-2020/

Why read it? *This report from EPE (Entreprises pour l'Environnement) on biodiversity tries to build a bridge between companies/business and biodiversity.*

Finance for Biodiversity Foundation. (2022). A*ligning financial flows with biodiversity goals and targets.* https://www.financeforbiodiversity.org/wp-content/uploads/Finance-for-Biodiversity-Foundation-Paper_Financial_Flows_16Feb2022.pdf

Why read it? *This position paper presents the point of view of practitioners and gives a concrete perspective on what can be done today on the markets.*

FIR and Iceberg Data Lab. (2021). Finance & biodiversity: understanding and acting. https://www.frenchsif.org/isr-esg/wp-content/uploads/FIR-IcebergDataLab_Finance-Biodiversity_oct21.pdf

Why read it? *This work is one of the few reports talking about finance and biodiversity.*

IPBES (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. S. Díaz, J. Settele, E. S. Brondízio, H. T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S. M. Subramanian, G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A. Pfaff, S. Polasky, A. Purvis, J. Razzaque, B. Reyers, R. Roy Chowdhury, Y. J. Shin, I. J. Visseren-Hamakers, K. J. Willis, and C. N. Zayas (eds.). IPBES secretariat, Bonn, Germany. 56 pages. https://doi.org/10.5281/zenodo.3553579

Why read it? *This report is a must-read scientific foundation on biodiversity, equivalent to the IPCC Global Assessment Reports. In simple terms, the Summary For Policymakers gives a precious overview of the state of biodiversity, the stakes of preserving it, and the main threats that human activities are generating.*

IPBES and IPCC (2021). *IPBES-IPCC co-sponsored workshop report on biodiversity and climate change*; Pörtner, H.O., Scholes, R.J., Agard, J., Archer, E., Arneth, A., Bai, X., Barnes, D., Burrows, M., Chan, L., Cheung, W.L., Diamond, S., Donatti, C., Duarte, C., Eisenhauer, N., Foden, W., Gasalla, M. A., Handa, C., Hickler, T., Hoegh-Guldberg, O., Ichii, K., Jacob, U., Insarov, G., Kiessling, W., Leadley, P., Leemans, R., Levin, L., Lim, M., Maharaj, S., Managi, S., Marquet, P. A., McElwee, P., Midgley, G., Oberdorff, T., Obura, D., Osman, E., Pandit, R., Pascual, U., Pires, A. P. F., Popp, A., ReyesGarcía, V., Sankaran, M., Settele, J., Shin, Y. J., Sintayehu, D. W., Smith, P., Steiner, N., Strassburg, B., Sukumar, R., Trisos, C., Val, A.L., Wu, J., Aldrian, E., Parmesan, C., Pichs-Madruga, R., Roberts, D.C., Rogers, A.D., Díaz, S., Fischer, M., Hashimoto, S., Lavorel, S., Wu, N., Ngo, H.T.. DOI:10.5281/zenodo.4782538.)

Why read it? *This is the first-ever report co-written by the two scientific bodies synthesising knowledge on climate and biodiversity: the IPCC and IPBES. Among others, it explores the notions of co-benefits and trade-offs between climate action and biodiversity preservation.*

SBTN (2020). *Science-based targets for nature - Initial guidance for business*. https://sciencebasedtargetsnetwork.org/wp-content/uploads/2020/09/SBTN-initial-guidance-for-business.pdf

Why read it? *How can companies start incorporating biodiversity in their strategy? The Science-Based Targets for Nature - Initial Guidance provides the first steps of such a journey. The in-development framework is largely expected to provide alignment for the private sector to engage on biodiversity.*

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., ... & Murray, C. J. (2019). *Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems*. The Lancet, 393(10170), 447-492. https://doi.org/10.1016/S0140-6736(18)31788-4

Why read it? *The EAT-Lancet report is a landmark article which establishes what constitutes a healthy diet in sustainable food systems that operates within planetary boundaries and which actions should be put in place to transform our food system. A groundbreaking article on a sustainable future for the food sector.*

Les Greniers d'Abondance. (2020). *Vers la résilience alimentaire. Faire face aux menaces globales à l'échelle des territoires*. 2nd édition, 184 p. https://resiliencealimentaire.org/wp-content/uploads/2021/01/VersLaResilienceAlimentaire-DigitaleVersion-HD-1.pdf

Why read it? *Co-written by les Greniers de l'Abondance, a NGO dedicated to the resilience of the food system and scientific experts, this report provides an overview of the current state of our food systems and identifies 11 paths to follow to make it resilient. An easy to read, clear, in-depth synthesis of the threats and opportunities in the food sector.*

Books

David, B. and Lecointre; G. (2022). *Le monde vivant.* Grasset.

Why read it ? *This book proposes over 100 short stories and anecdotes on the living beings and systems, minerals, and their link with our societies.*

Génot, J-C. (2020) *La nature malade de la gestion*. Hesse Editions.

Why read it ? *This book proposes a deep dive into the heart of the debates of nature managers, i.e. ecologists, foresters and planners. J-C Génot sheds light on the fact that the "management of living organisms" is traditionally based mainly on their control via bio-engineering, and that the functioning of ecosystems and their resilience is still poorly understood and protected.*

Tordjman, H. (2021). *La croissance verte contre la nature: Critique de l'écologie marchande*. Edition la Découverte.

Why read it ? *In this work, the author discusses diverse topics: the process of privatisation of genetic resources, what is underlying in monetary valuations of ecosystem services, the compensation mechanisms applied to biodiversity, etc. An interesting perspective on questions that are far from being neutral from an ethical and philosophical perspectives.*

Website / Institutions

The World Resource Institute website, https://www.wri.org/

Why look at it ? *The WRI is a global research non-profit organisation working on a range of topics linked to sustainability. Their website is a great resource, where one can find out more about the insightful research they produce, and look at their numerous and various reports, studies, case studies and datasets to better understand the dynamics and causes of biodiversity loss and environmental degradation, and how to address these issues.*

Act4nature: http://www.act4nature.com/

Why look at it ? *This platform is a good way to discover the individual commitments taken by 57 companies in favour of nature. These commitments have been recognised as SMART by the Act4nature international multi-stakeholders steering committee.*

Podcast

"Pour que nature vive", produced by the Muséum National d'Histoire Naturelle and Création Collective, in partnership with the Ministry of Ecological Transition.

Why listen to it? *This podcast (in French only) is a good way to delve into issues related to biodiversity, in particular questions exposed in the first part of this report (e.g. what is biodiversity? Which economic tools can be used to curb biodiversity loss? How are health and biodiversity related, or demography and the environment ?). Each episode is an interview of an expert/ researcher working on the topic.*

Video / documentary

Fothergill, A., Butfield, C., Garwood, K., Scholey, K., Zeitz, J. (Producers) & Clay, J. (Director). (2021). *Breaking Boundaries: The Science of Our Planet.*

Why watch it ? *Planetary Boundaries represent the most holistic environmental assessment framework of our time. The voice of David Attenborough, and the rigorous explanations of Johan Rockström will guide you through it in this documentary.*

Rockström, J. (2010). *Let the environment guide our development*. Video]. TED Conferences. https://www.ted.com/talks/johan_rockstrom_let_the_environment_guide_our_development?language=en

Why watch it ? *Filmed in 2010, this groundbreaking presentation by the worldwide renowned scientist Johan Rockström will introduce you to the planetary boundaries, and the irreversible effects of crossing them.*

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