Iceberg Data Lab

Enabling Sustainable Goals

Corporate Biodiversity Footprint- Methodological guide

Version: February, 2023

Executive summary

This guide aims to provide methodological guidance on the Corporate Biodiversity Footprint (CBF), Iceberg Data Lab's corporate biodiversity footprint assessment tool meant to provide annual assessment of the biodiversity impacts of corporates, financial institutions and sovereign issuers.

This footprinting method is designed to support the needs of financial actors regarding their investment strategies (portfolio or index development, exclusions, risk management), reporting requirements, stewardship, and engagement policies. The CBF is based on the underlying activities of the issuer which are the sources of its impact on nature. The CBF follows the generally accepted environmental accounting rules, uses a science-based approach covering all the material impacts of the corporates supply chain, processes, and products throughout their value chain. In addition, the sources used for the calculation and the transparency level of the analysed entity or asset are reflected in a dedicated data quality indicator for each data point. The footprint method of the CBF is based on life cycle assessment, therefore following recommendations on footprinting methods[1] and the Organisation Environmental Footprint (OEF) Guide[2] , published bythe European Commission.

The CBF is aligned with the Sustainable Finance Disclosure Regulation[3] (SFDR). The CBF can also be used by Iceberg Data Lab's consulting partners to support companies in their process to meet the Corporate Sustainability Reporting Directive (CSRD)[4]. While the CBF provides insight on the corporate impact on biodiversity, the *Dependency Score* – a separate product – provides insight on the corporate dependencies on biodiversity and ecosystem services. Used together, they allow for reporting based on the double materiality principle as defined by the European Commission[4]..

Date	Version	Main author	Reviewer	Diffusion
February 20, 2023	V3.5	Clément Molinier	Delphine Bartre	Client

[1] Commission Recommendation 2013/179 (EU) of 9 April 2013 on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations. *OJ L*.124. http://data.europa.eu/eli/reco/2013/179/oj/eng.

[2] Deliverable 3 and 4B to the Administrative Arrangement between DG Environment and Joint Research Centre No. N 070307/2009/552517, including Amendment No 1 from December 2010. https://ec.europa.eu/environment/archives/eussd/pdf/footprint/OEF%20Guide_final_July%202012_clean%20version.pdf

[3] Regulation (EU) 2019/2088 of the European Parliament and of the Council of 27 November 2019 on sustainability-related disclosures in the financial services sector [2019] OJ L317/1

[4]Directive (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022 amending Regulation (EU) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as regards corporate sustainability reporting [2022] OJ L322/15

Glossary

- Corporate Biodiversity Footprint

The Corporate Biodiversity Footprint is a measuring tool of biodiversity footprint.
The CBF is designed to assess the annual impact of activities of corporates, financial institutions, real assets and sovereign entities on global and local biodiversity. This appraisal is based on the impact generated from the products purchased or sold by companies calculated throughout their value chain.

- Dependency Score

The Dependency score measures the dependencies of an economic sector to ecosystem services. It illustrates how that sector can take advantage of the given service and how disruption of the service might negatively impact the economic sector. This measurement is provided by a final score aggregating three sub-scores corresponding to provisioning, regulating and cultural services.

- Carbon dioxide equivalents (CO2-eq)

The 100 year radiative capacity of each kg of molecule is compared to the radiative capacity of a kg of CO2 during the same period. The table below shows the ratio of the radiative capacity of some molecule:

Common Name	Formula	Chemical Name	AR4
Carbon dioxide	CO2		1
Methane	CH4		25
Nitrous oxide	N2O		298
Nitrogen trifluoride	NF3		17 200
Sulfur hexafluoride	SF6		22 800
Hydrofluorocarbons (HFCs)			
HFC-23 (R-23)	CHF3	trifluoromethane	14 800
HFC-32 (R-32)	CH2F2	difluoromethane	675
HFC-41 (R-41)	CH3F	fluoromethane	92
HFC-125 (R-125)	C2HF5	pentafluoroethane	3 500
HFC-134 (R-134)	C2H2F4	1,1,2,2-tetrafluoroethane	1 100
HFC-134a (R-134a)	C2H2F4	1,1,1,2-tetrafluoroethane	1 430
HFC-143 (R-143)	C2H3F3	1,1,2-trifluoroethane	353
HFC-143a (R-143a)	C2H3F3	1,1,1-trifluoroethane	4 470
HFC-152 (R-152)	C2H4F2	1,2-difluoroethane	53
HFC-152a (R-152a)	C2H4F2	1,1-difluoroethane	124
HFC-161 (R-161)	C2H5F	fluoroethane	12
HFC-227ea (R-227ea)	C3HF7	1,1,1,2,3,3,3-heptafluoropropane	3 220
HFC-236cb (R-236cb)	C3H2F6	1,1,1,2,2,3-hexafluoropropane	1 340
HFC-236ea (R-236ea)	C3H2F6	1,1,1,2,3,3-hexafluoropropane	1 370
HFC-236fa (R-236fa)	C3H2F6	1,1,1,3,3,3-hexafluoropropane	9 810
HFC-245ca (R-245ca)	C3H3F5	1,1,2,2,3-pentafluoropropane	693
HFC-245fa (R-245fa)	C3H3F5	1,1,1,3,3-pentafluoropropane	1 030
HFC-365mfc	C4H5F5	1,1,1,3,3-pentafluorobutane	794
HFC-43-10mee (R-4310)	C5H2F10	1,1,1,2,3,4,4,5,5,5-decafluoropentane	1 640

Table 1: Ratio of radiative capacity for different GHG compared to CO_2. Source: GHG Protocol & the Fourth Assessment Report (AR4) of the United Nations Intergovernmental Panel on Climate Change (IPCC)

The term of CO2eq is thus a measure of the radiative capacity which is linked to global warming. The emissions of a company in CO2eq aggregate all the different gas emitted by the company weighted by their radiative capacity.

- Footprint

Footprints are, in an environmental context, measures of humans’ direct and indirect impact on the natural world: usually by adding or subtracting something that has a quantifiable effect on the ecosystem. The impact of a commodity, company, person or community on global biodiversity, measured in terms of biodiversity change, as a result of production and consumption of particular goods and services. The footprint is calculated according to 3 scopes described in part *3.1 Scopes* , and in line with the GHG protocol.

- Greenhouse gases emissions (GHG)

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 property causes the greenhouse effect. Water vapor (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary GHGs in the Earth's atmosphere. Moreover, there are a number of entirely human-made GHGs in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Beside CO_2, N_2O and CH_4, the Kyoto Protocol deals with the GHGs sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

- GLOBIO

The GLOBIO model expresses the response of ecosystems to anthropogenic pressures. This response is evaluated from a set of quantitative relationships and is expressed in Mean Species Abundance-MSA for each of the pressures taken into account by the model. These pressures are climate change, atmospheric nitrogen deposition, land use, infrastructure and human encroachment.

The MSA values per pressure are calculated on the basis of empirical data allowing to compare the species observed in disturbed and undisturbed reference habitats. All in all, the GLOBIO model covers six taxonomic groups: amphibians, birds, mammals, terrestrial invertebrates, reptiles, and vascular plants.

- Indicator

A quantitative or qualitative factor or variable that provides a simple and reliable way to measure achievements, reflect changes related to an intervention, or help assess the performance of a development actor.

- International Energy Agency (IEA)

The International Energy Agency IEA is at the heart of global dialogue on energy, providing authoritative analysis, data, policy recommendations, and real-world solutions to help countries provide secure and sustainable energy for all.

- International Monetary Fund (IMF)

The International Monetary Fund (IMF) works to achieve sustainable growth and prosperity for all of its 190 member countries. It does so by supporting economic policies that promote financial stability and monetary cooperation, which are essential to increase productivity, job creation, and economic well-being. The IMF is governed by and accountable to its member countries.

- Intergovernmental Panel on Climate Change (IPCC)

Created in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), the objective of the IPCC is to provide governments at all levels with scientific information that they can use to develop climate policies. IPCC reports are also a key input into international climate change negotiations. The IPCC is an organization of governments that are members of the United Nations or the WMO. The IPCC currently has 195 country members. Thousands of people from all over the world contribute to the work of the IPCC. For the assessment reports, IPCC scientists volunteer their time to assess the thousands of scientific papers published each year to provide a comprehensive summary of what is known about the drivers of climate change, its impacts and future risks, and how adaptation and mitigation can reduce those risks. An open and transparent review by experts and governments around the world is an essential part of the IPCC process, to ensure an objective and complete assessment and to reflect a diverse range of views and expertise. Through its assessments, the IPCC identifies the strength of scientific agreement in different areas and indicates where further research is needed. The IPCC does not conduct its own research.

- Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES)

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is an independent intergovernmental body established by States to strengthen the science-policy interface for biodiversity and ecosystem services for the conservation and sustainable use of biodiversity, long-term human well-being and sustainable development. It was established in Panama City, on 21 April 2012 by 94 Governments. It is not a United Nations body. However, at the request of the IPBES Plenary and with the authorization of the UNEP Governing Council in 2013, the United Nations Environment Programme (UNEP) provides secretariat services to IPBES. IPBES currently has close to 140 member States. The work of IPBES includes assessments on specific themes (e.g. “Pollinators, Pollination and Food Production”); methodological issues (e.g. “Scenarios and Modelling); and at both the regional and global levels (e.g. “Global Assessment of Biodiversity and Ecosystem Services”) ; as well as Policy Support (Identifying policy-relevant tools and methodologies, facilitating their use, and catalyzing their further development) and Building Capacity & Knowledge for member states, experts and stakeholders.

- Taskforce on Nature-related Financial Disclosures - TNFD

Taskforce on Nature-related Financial Disclosures (TNFD) aims to develop and deliver a risk management and disclosure framework for organizations to report and act on evolving nature-related risks. In 2023, I Care by BearingPoint and Iceberg Data Lab (IDL) partnered with 4 financial institutions: BNP Paribas, Crédit Agricole S.A., Mirova, and SCOR, to conduct a Taskforce on Nature-related Financial Disclosures (TNFD) pilot on the agrifood sector with a sample of 123 companies operating globally.[5]

- Life Cycle Assessment (LCA)

Life cycle assessment is an integrated evaluation of the potential environmental impacts associated with the production of a good or service, taking into account all or part of the production stages, from the supply chains of raw materials to the end of the product's life. It is a standardized approach that identifies and quantifies the physical flows of materials and energy associated with human activities throughout the life of a product. It evaluates the potential impacts and then interprets the results obtained according to its initial objectives. An analysis of incoming and outgoing flows (materials, energy, waste, etc.). Models are then used to translate this into pressures and intermediate impacts (e.g. climate change, habitat modification, eutrophication) and final impacts (on the state of biodiversity, ecosystem services).

- Planbureau voor de Leefomgeving Netherlands Environmental Assessment Agency (PBL)

PBL Netherlands Environmental Assessment Agency is the national institute for strategic policy analysis in the fields of the environment, nature and spatial planning.

- Positive Impact

The Positive Impact are indicators which allow to measure and quantify factually positive impacts on nature due to improved performance and compensation actions carried out by companies. These indicators quantify

[5] To download the Final Report, ask further questions or interested in conducting a similar pilot, please reach out contact@icebergdatalab.com

the positive impact that these management decisions have on nature. It can be analysed through reduced, avoided or compensated impacts that are detailed in this report.

- World Resources Institute (WRI)

The World Resources Institute (WRI) is a global research non-profit organization established in 1982. WRI's activities are focused on seven areas: food, forests, water, energy, cities, climate and ocean.

Contents

1 Overall context

Often referred to as the sixth mass extinction, the current acceleration of global biodiversity loss is one of the most significant threats to society (OECD, 2019). The steep increase of the rate of species loss since 1900 provides a measure of the scale of this global phenomenon (IPBES, 2019). The average abundance of native species in most major land-based habitats has fallen by at least 20% and 25% of all species are threatened today with extinction (IPBES, 2019). Of the global limits set for the nine Earth processes essential to sustain human life on Earth, three have already been exceeded[6,7] as shown in figure 1. Of these, the global biodiversity limit has been exceeded the most. Through the reduction in the provision of ecosystem services, estimated to be worth US$125-140 trillion annually, and natural resources, this extinction threatens the sustainability of economic models and the financial system[8].

For corporates and financial institutions, the degradation of global biodiversity poses both a direct threat, through the depletion of the natural capital resources they exploit and the ecosystem services that support their business. This double materiality of biodiversity was also recognized by the EU in recent regulation developments, namely the Corporate Sustainability Reporting Directive (CSRD) and the Sustainable Finance Disclosure Regulation (SFDR), which require companies and financial institutions to report on some aspects related to their impacts on biodiversity.

In this context, and lacking clear visibility of their environmental impact, some companies and financial institutions are increasingly interested in natural capital accounting to mitigate their impacts and measure their risk. A new set of indicators are needed to supplement the traditional financial key performance indicators.

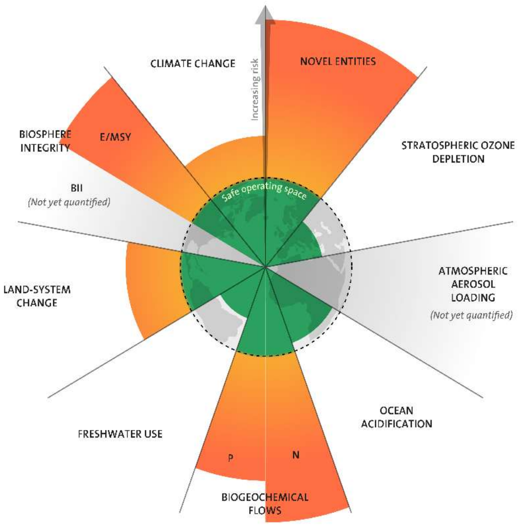

Figure 1: Illustration of the planetary limits for the nine Earth system processes that are essential for maintaining favourable conditions for human development (Rockström et al., 2022).

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[6] Lucas, P., Wilting, H., Paul Lucas, A., Wilting Supervisor Olav-Jan van Gerwen, H., 2018. TOWARDS A SAFE OPERATING SPACE FOR THE NETHERLANDS: Using planetary boundaries to support national implementation of environment-related SDGs. Policy Brief. The Hague.

[7] Rockström, Johan, Will Steffen, Kevin Noone, Åsa Persson, F Stuart Chapin III, Eric F Lambin, Timothy M Lenton, et al. 2009. « A safe operating space for humanity ». *Nature* 461 (September): 472.

[8] Suttor-Sorel, L., 2019. Making Finance Serve Nature. From the niche of Conservation finance to the mainstreaming of Natural Capital approaches in financial systems.

2 The Corporate Biodiversity Footprint Methodology

2.1 The MSA metric to quantify the impact on Biodiversity

The « **Mean Species Abundance** » (**MSA**) is a biodiversity metric expressing the average relative abundance of native species in an ecosystem compared to their abundance in an ecosystem undisturbed by human activities and pressures. This indicator is based on species abundance[9] and therefore measures the conservation status of an ecosystem in relation to its original state,. For instance, an area with an MSA of 0% will have completely lost its original biodiversity (or will be exclusively colonised by invasive species) whereas an MSA of 100% reflects a level of biodiversity, equal to an original, undisturbed ecosystem.

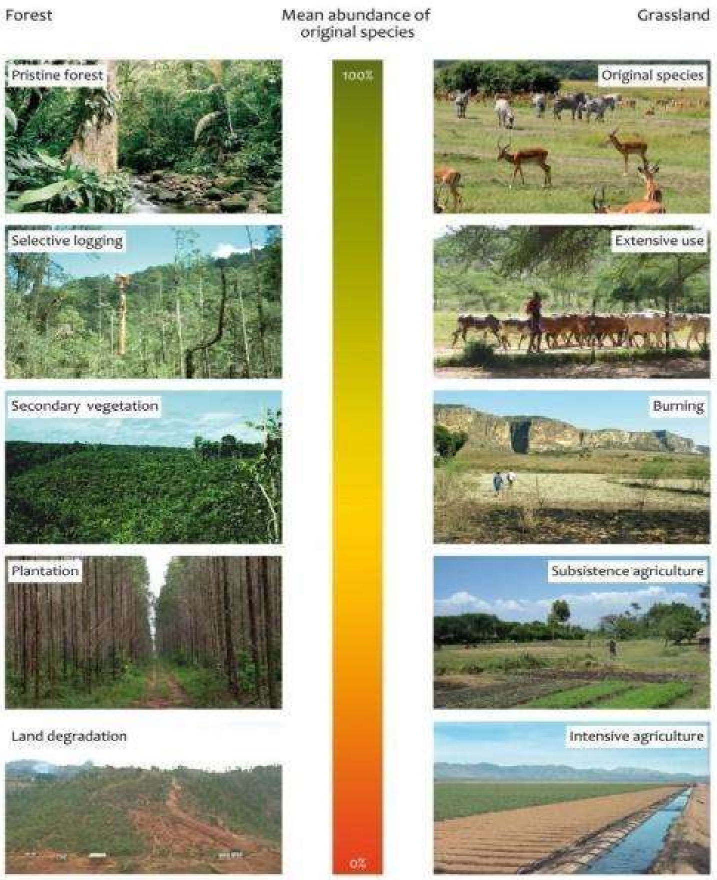

Figure 2: Photographic illustration of MSA variation for forest and grassland ecosystems (GLOBIO, 2019).

This indicator was proposed as part of the development of the open-source database version GLOBIO3 model the objective of which is to simulate the impact of different human pressure scenarios on biodiversity.

The GLOBIO model was developed by PBL, the Netherlands Environmental Assessment Agency, and designed to support decision-makers by quantifying global human impacts on biodiversity. GLOBIO calculates the local terrestrial biodiversity intactness, expressed by the MSA indicator. The core of the model consists of

[9] Species abundance is the number of individuals per species, and relative abundance refers to the evenness of distribution of individuals among species in a community (Encyclopedia Britannica).

quantitative pressure-impact relationships that have been established based on extensive terrestrial biodiversity databases.

The CBF methodology uses the Mean Species Abundance (MSA) metric to quantify Biodiversity impact because:

- it offers the largest and more robust toolbox in terms of damage functions in the scientific literature,
- it is a holistic approach of the biodiversity impact of corporates adapted to appraise extensive universes, unlike more microscopic indicators (endangered species, availability of specific ecosystem services) which are fitter for project-level analysis,
- it is endorsed by the international scientific community and multilaterals (IPBES, IPCC, 2007), and recommended by the United Nations for the measurement of biodiversity (CBD, 1997),
- It is a commonly used metric for measuring the biodiversity footprint of companies, showing several already been published case studies[10, 11, 12, 13,14,15]

The CBF is a footprinting approach expressed in the Km^2.MSA unit and corresponds to a negative impact (footprint) on biodiversity (i.e. the difference between an initial and a final state of biodiversity).

This unit has pedagogical virtues and makes the score result easily understandable by non-experts. For example, -1 Km^2.MSA corresponds to the biodiversity value contained in 1Km^2 of tropical pristine forest undisturbed by human activities.

2.2 Factoring the pressures from the corporates' businesses

The CBF models the impact of corporates on biodiversity through four main environmental pressures on species and habitats.

- Change of land use: with occupational, transformational, incremental, encroachment and fragmentation
- Climate change: due to greenhouse gases emissions (GHG emissions)
- Air Pollution: leading to the ecosystems' disturbance due to terrestrial eutrophication and acidification (Nitrogen and Sulphur emissions respectively)
- Water Pollution: Freshwater ecotoxicity with the release of toxic compounds in the environment and plastic entanglement

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[10] Baltussen, W, T Achterbosch, E Arets, A de Blaeij, N Erlenborn, V Fobelets, P Galgani, et al. 2016. *Valuation of livestock eco-agri-food systems: poultry, beef, and dairy*. *Wageningen, Wageningen University and Research, publication 2016-023*.

[11] Chaplin-Kramer, Rebecca, Sarah Sim, Perrine Hamel, Benjamin Bryant, Ryan Noe, Carina Mueller, Giles Rigarlsford, et al. 2017. « Life cycle assessment needs predictive spatial modelling for biodiversity and ecosystem services ». *Nature Communications* 8 (1): 15065. https://doi.org/10.1038/ncomms15065.

[12] Bie, Steven De, et Jolanda Van Schaick. 2011. « COMPENSATING BIODIVERSITY LOSS Dutch companies' experience with biodiversity compensation, including their supply chain, The 'BioCom' Project. De Gemeynt, Klarenbeek. »

[13] Wilting, H.C., van Oorschot, M.M.P., 2017. Quantifying biodiversity footprints of Dutch economic sectors: A global supply-chain analysis. J. Clean. Prod. 156, 194–202. https://doi.org/10.1016/j.jclepro.2017.04.066

[14] BNP Paribas Asset Management, June 2022. *SUSTAINABLE BY NATURE SEQUEL: OUR PORTFOLIO BIODIVERSITY FOOTPRINT*. https://docfinder.bnpparibas-am.com/api/files/60B8656F-6A6F-4A35-9244-A997DCCB59FD

[15] Axa Group, June 2022. *Climate and Biodiversity Report Accelerating Transition*. https://www-axa-com.cdn.axa-contento-118412.eu/www-axa-com/3989afa7-966b-40b4-9280-c57c7b82191a_AXA-2022_Climate-and-Biodiversity-report.pdf

These pressures are calculated along the whole value chain of the corporate, appraising their processes, products, and supply chains. All pressures are aggregated into scope 1, 2 and 3 (upstream and downstream) according to the definitions and boundaries set forth in the GHG Protocol.

2.3 How is the CBF computed?

1. The first step, our internal physical Input/Output model Wunderpus maps the flows and purchases of goods and services (called "Commodities") on which depend its activity and allocate the company's product flows by NACE[16] sector. Certain company practices, all other things being equal, reduce the level of pressure through the existence of certain sustainable forest management practices, certifications and labels (called "Attributes") ;

2. The second step is to assess and calculate each environmental pressures of the company, which will be based on its activity's mix ;

3. The third step is to translate all the pressures through pressure-impact damage functions (based on GLOBIOmodel) into a same biodiversity impact unit, which is Km^2.MSA ;

4. The final step is to aggregate the different impacts in an overall absolute impact and calculate several ratios (physical and financial ones). It avoids biases due to entity size and more accurately assesses its impact.

The calculation and the global approach of the CBF are following the different steps in the following figure :

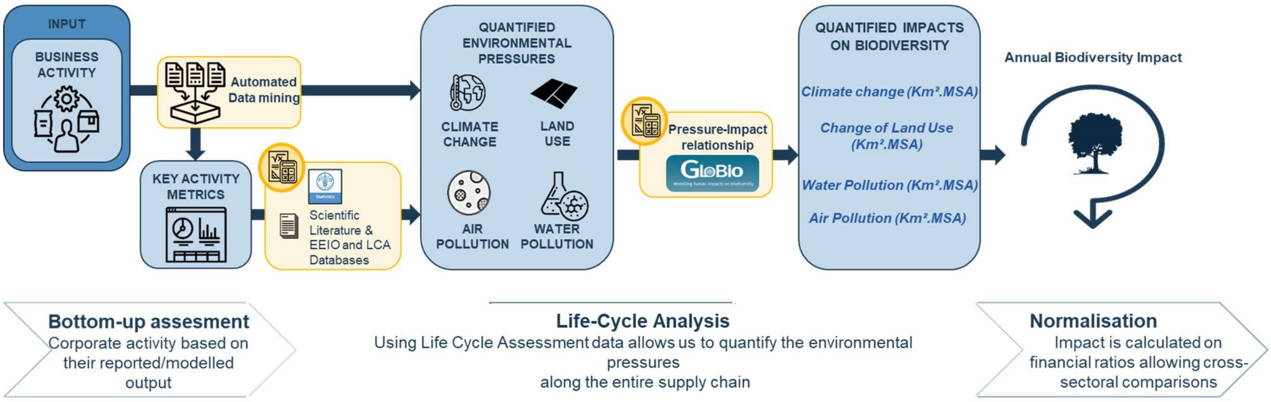

Figure 3: Illustration of the global approach and modelling process of IDL's biodiversity accounting methodology.

2.4 Translating different pressures in a common biodiversity impact metric

For each activity of a company, we assess every international pressure on biodiversity translated into a quantified impact on biodiversity expressed in km^2.MSA. This step requires pressure-impacts damage functions to link every pressure to an associated impact on biodiversity.

[16] The European classification system of economic activities

The damage functions come from different scientific and academic sources. The GLOBIO model is used for damage functions related to land use change as well as meta-analysis from the scientific literature for other pressures such as climate change. Finally, other reference sources, are used to model other damage functions related to water pollution. The damage functions are then improved in partnership with our partner scientific and depending on our needs and the granularity of the data.

A negative result indicates an overall negative contribution to biodiversity conservation (i.e. decrease of biodiversity abundance).

The next illustration shows how data is processed from the modeling of commodities based on revenues over applying pressures to the calculation of the impact.

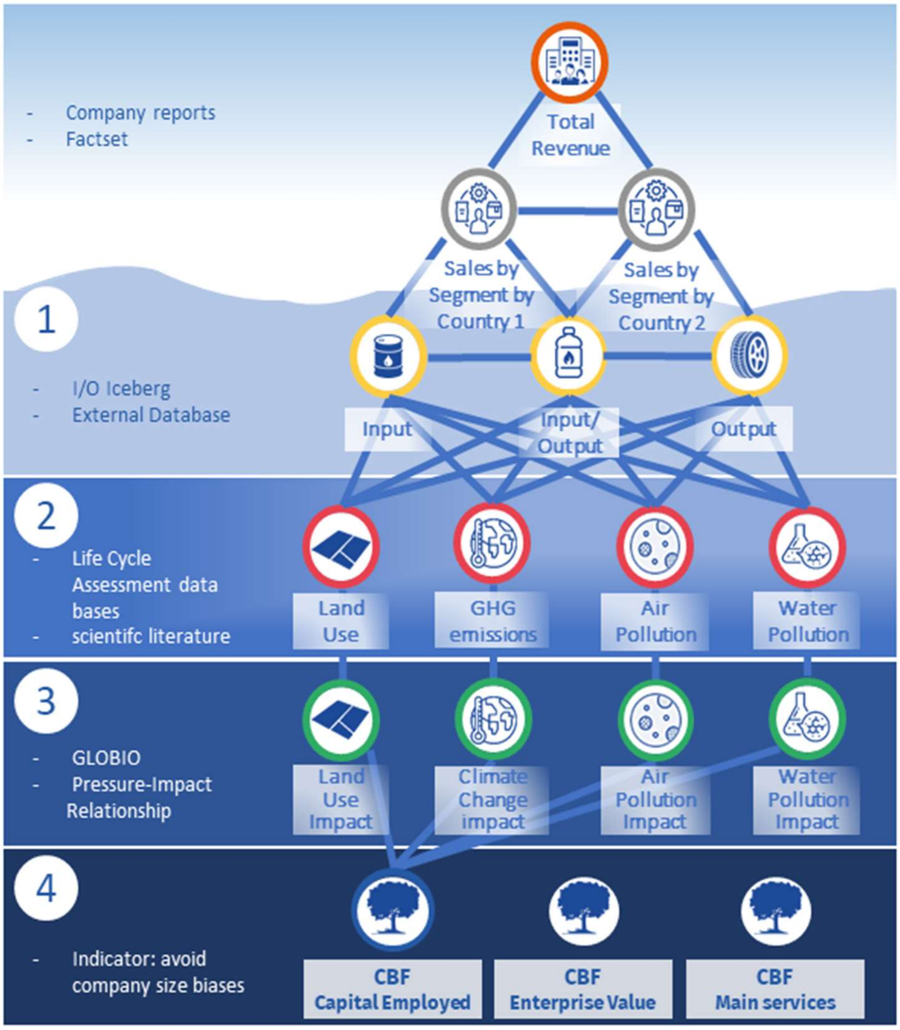

Figure 4: Data processing and modelling from financial data and company reports to environmental indicators

3 The different pressures

The Corporate Biodiversity Footprint (CBF) aims at covering the most material pressures on Biodiversity, as summarized in the IPBES reports (i.e. land and sea use change, pollution, climate change, direct exploitation of biological resources and invasive species).

The capacity of Iceberg Data Lab to assess the impact of corporate relies on the robustness, reliability, responsiveness, comprehensiveness and availability of science-based approaches developed by academics and environmental experts. The main limiting factor is the existence of robust relation between the pressures and the impact expressed in Km².MSA and the availability of data at corporate level to document the most material impacts. Of particular importance are the capacity to provide a level playing field to compare issuers in the same sector and to provide a correct "merit order" of the pressures/impacts/corporates.

The Corporate Biodiversity Footprint assesses the most material pressures on terrestrial biodiversity shown in Figure 5.

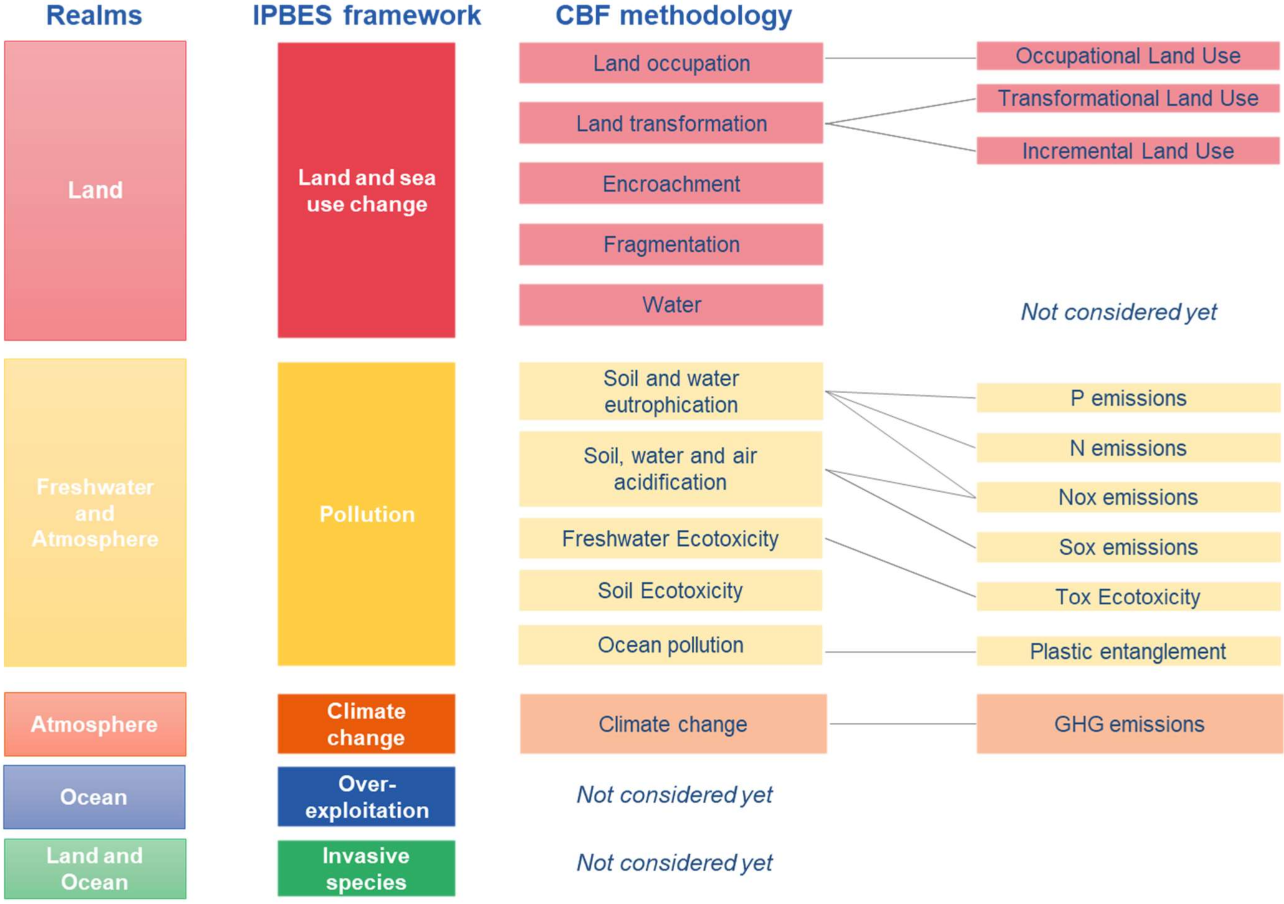

Figure 5: Mapping of IPBES pressures on biodiversity to pressures accounted for in the CBF

3.1 Scopes

Based on the GHG Protocol, we define the scopes in the following way for the pressures on biodiversity:

- **"Scope 1":** all direct pressures and impacts generated in the area controlled by the entity and other impacts directly caused by the entity during the assessed period.

For GHG emissions they come from the combustion of fossil fuels, or chemical reactions.
For Change of Land Use, they're linked to surface artificialized or occupied directly by the company.

- **"Scope 2"**: all pressures and impacts resulting from non-fuel energy (electricity, steam, heat and cooling purchases) generation for site-level use, including impacts resulting from land use changes, etc.

- **"Scope 3"**: all indirect pressures induced by the activity of a company. This scope is very often split in 2 sub scopes: scope 3 upstream and scope 3 downstream. Each of this sub scope is furthermore split. The scope 3 upstream is associated with the product purchased by the company, while the scope 3 downstream mostly corresponds to the product sold by the company.

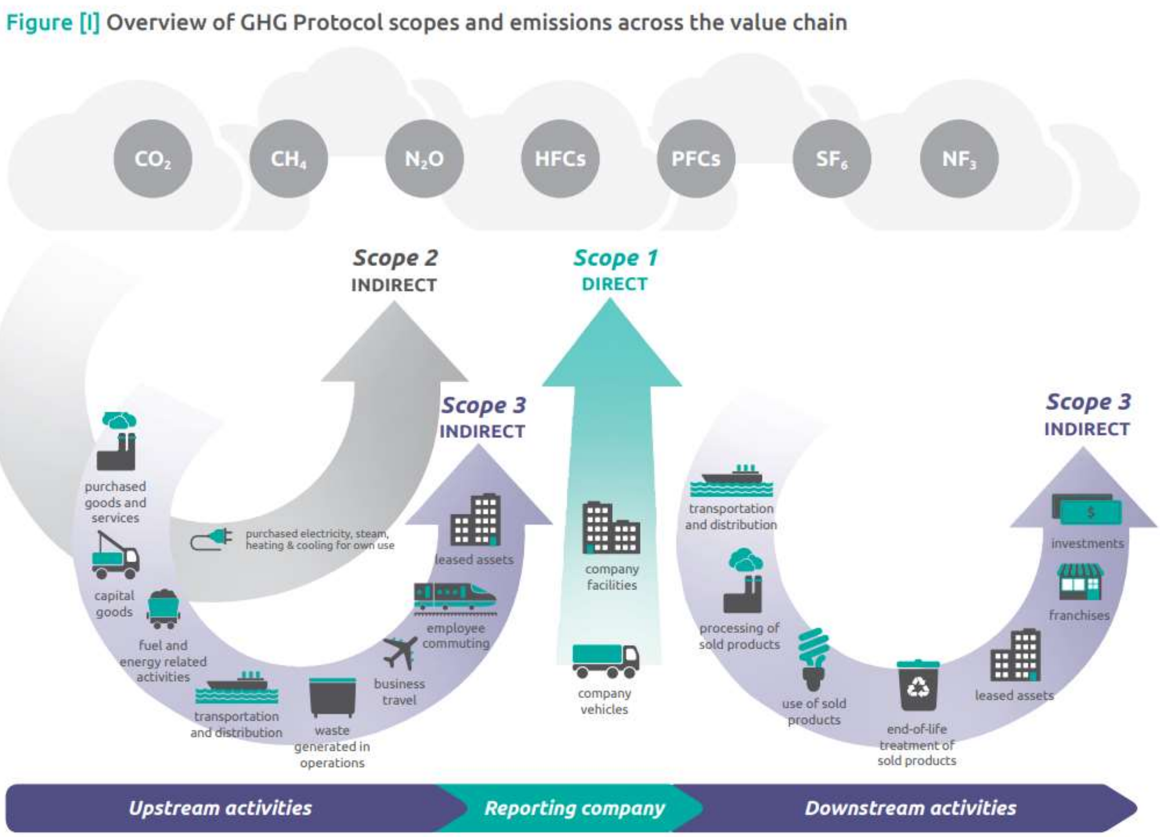

Figure 6: GHG Calculation and Scope 3 footprint calculation

3.1.1 The Change of Land use

Land use is defined as the human use of a specific area for a certain purpose (such as residential; agricultural; recreation; industrial, etc.) whereas land use change refers to a change in use or management of land by humans (IPBES 2020). Land use change is the leading cause of global biodiversity loss due to its direct impact on habitats of species.

Within the "Change of Land use" pressure, the CBF methodology currently models the following sub-pressures :

- **Occupational land-use**
- **Transformational land-use which aggregates incremental, fragmentation and encroachment**

- **Occupational land-use** corresponds to maintaining an area in different biodiversity level than before due to a current operation, which prevents its return to a pristine state. Land occupation impacts correspond to the biodiversity loss due to the ongoing operation of the company (for instance, operating a factory).
- **Transformational land-use** refers to the area of land that is transformed during the year to maintain the same level of production and consumption as in the previous year, with an improved or deteriorated biodiversity abundance. Land transformation impacts correspond to the difference in biodiversity abundance before and after transformation, over the area considered and the time required for a spontaneous return to a pristine state, which is considered as the relaxation [17].

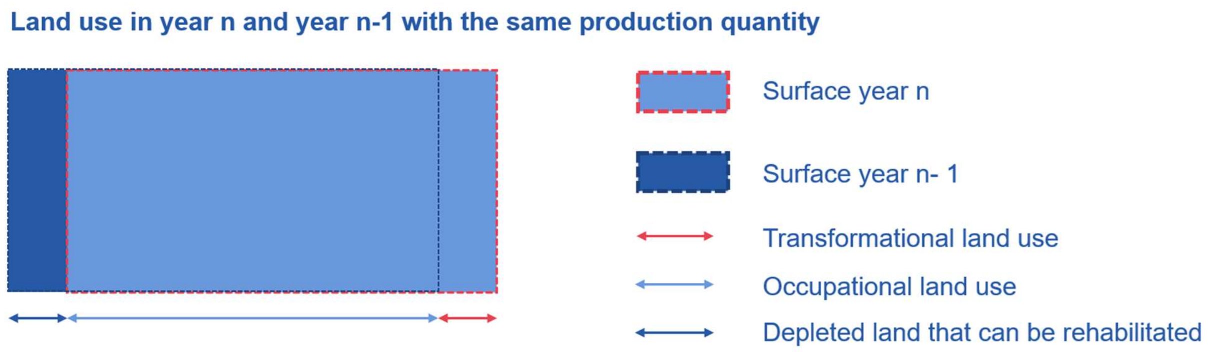

Figure 7 Illustration of the evolution of the pressure "land use" of a company between two years of production and exploitation.

[17] The concept of relaxation time comes from Life Cycle Analysis (LCA) and represents the time required for an ecosystem to return naturally to its initial state. Due to ecological considerations, such a concept is of course very locally dependent. Ranges go from 7 years required for open biomes to restore to 1000 years for natural forests, depending on sources, the definition of restoration, past degradation, etc.

Based on location hypotheses, available data and type of commodity, different relaxation times are used to calculate the transformational, incremental and the occupational land use.

For some activities, e.g. mining, transformational land use occurs if the resources of the previously occupied surface are depleted, and the activity needs to move to an area where the necessary resources are available to maintain a stable output.

Three secondary sub-pressures result in Transformational land use :

- **Incremental land use** corresponds to the additional surface that a corporate occupies compared to the previous year. This incremental land use is triggered by the increase of production or consumption which leads globally to a change of land use and reflects the evolution in the production level of the company. In comparison to transformation land use, the incremental land use does not necessarily convert land. However, the Incremental land use leads generally to the transformation of natural landscapes into agricultural or industrial areas.

- **Fragmentation** emphasizes the impact of human activities through the splitting of natural landscape like forests or grassland. Divided in several pieces, those ecosystems are less resilient and local biodiversity tends to decrease.

- **Encroachment** corresponds to the perturbation induced through lights and noises that can lead to biodiversity loss. This perturbation affects an area around the occupied area, the size of the area obviously depends on the type of assets occupied. It typically occurs around transport infrastructure such as highways or railways.

Then, the value of the four sub-pressures are aggregated to give the final value of the "Change of Land Use" pressure.

3.2 Pollution

The Corporate Biodiversity Footprint considers several types of pollution, air, and water pollution. Depending on the sectors, and on their contribution to global emissions of pollutants, diverse pollution flows are considered.

3.2.1 Air Pollution

"Air pollution" aggregates terrestrial acidification and terrestrial eutrophication. Our model factors the most material sources of air pollution, which are the emissions of Nitrogen (impacts on terrestrial acidification and eutrophication) and of Sulphur (terrestrial acidification impact).

Figure 8: Air Pollution Pressures

Acidification	**Eutrophication**
Terrestrial acidification is a natural process occurring in various ecosystems (Forests, grasslands mainly) consisting in a decrease in soil pH. Acid precipitations are the main driver of anthropogenic terrestrial acidification, and they are caused by the release and reactions of Sulphur and Nitrogen in the air. These emissions are ultimately deposited and dissolved in soil solutions. These impacts drive to low soil fertility (yellowing of plant leaves, seed germination failure, decrease in new root production, etc.). This finally results in a lower local biodiversity.	Eutrophication is a natural phenomenon due to an excess of Nitrogen and Phosphorus compounds in the ecosystem. Eutrophication usually happens in water (freshwater or marine), but the concept can also be extended to land. In terrestrial environments , an additional input of nutrients (Nitrogen mainly) on a natural ecosystem induces a natural selection of nitrophilous/phosphorus plants, which changes the species distribution of the ecosystem (leaves, seed germination failure, decrease in new root production, etc.). This finally results in a lower local biodiversity.

The impact of air pollution on biodiversity differs from sector to sector. Generally, Air Pollution is high in sectors with combustion and high-temperature processes like, for instance, the Power sector.

3.2.2 Water pollution

The CBF models and quantifies two sub-pressures of water pollution :

- **Freshwater Ecotoxicity (related to the release of toxic compounds into freshwater)**
- **Plastic Entanglement (related to marine species)**

Freshwater ecotoxicity is caused by the release of artificial organic or inorganic chemicals into ecosystems, also called toxic compounds (Tox), into the environment by companies. The CBF uses toxicity data from several academic sources[18] which characterize the ecotoxicological impacts of chemical emissions in life cycle assessments.

For instance, the graph below shows a non-exhaustive list of chemicals released due to soy cultivation, leading to the Water Pollution (Freshwater ecotoxicity) impact on that Product.

[18] UNEP, SETAC

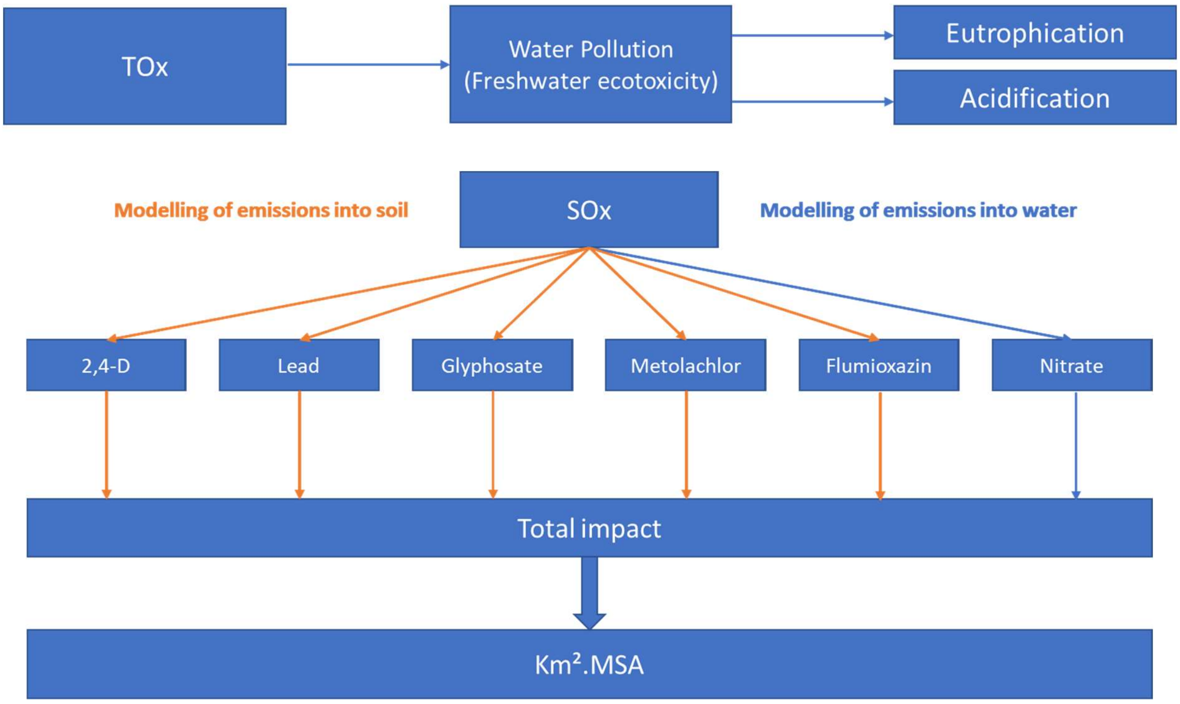

Figure 9: Modeling of toxic compounds of Water Pollution into the CBF methodology.

The biodiversity impact of Water Pollution is especially material in sectors using a great amount of chemicals and toxic compounds like, for instance, the Metals and Mining sector.

Plastic entanglement refers to marine organisms entrapped in plastics which leads to death or impaired movement or growth. Even if plastic entanglement refers to an impact on marine biodiversity, we chose to integrate it as part of the Water Pollution as pressure.

3.3 Climate Change

Climate change affects biodiversity by causing shifts in species distribution, often associated with decreases in local species population[19] as some species often cannot adapt as quickly as needed to climate change. The increase of the global average temperature leads to a biodiversity loss of all biomes of the planet.

The link between GHG emissions and biodiversity impacts expressed in relative MSA is based on damage functions and scientific literature[20,]. º

[19] Alkemade, Rob, Michel Bakkenes, et Bas Eickhout. 2011. « Towards a general relationship between climate change and biodiversity: An example for plant species in Europe ». *Regional Environmental Change* 11 (SUPPL. 1): 143-50. https://doi.org/10.1007/s10113-010-0161-1.

[20] Joos, F., R. Roth, J. S. Fuglestvedt, G. P. Peters, I. G. Enting, W. Von Bloh, V. Brovkin, et al. 2013. « Carbon dioxide and climate impulse response functions for the computation of greenhouse gas metrics: A multi-model analysis ». Atmospheric Chemistry and Physics 13 (5): 2793-2825. https://doi.org/10.5194/acp-13-2793-2013.

With the global surface of the biomes and the integrated absolute global average temperature increase (GMTI) potential of CO_2 on a 100-year time horizon, we are able to model the biodiversity loss in Km^2.MSA as a function of GHG emissions (tons of CO_2eq emitted into the atmosphere).

GHG emissions and their contribution to biodiversity loss is especially important for sectors like Oil & Gas or Power as those sectors are highly CO2 emitting due to their high consumption of fossil fuels.

3.4 From pressures to impact

Several types of pressures exist with local or global impacts. In our model, one pressure can be analyzed from a local point of view, i.e. change of land-use. While the three other pressures (climate change, air pollution and water pollution) can be analyzed from a global point of view because of the circulation of resources, whether atmospheric or oceanic. These pressures will then generate global impacts on all major planetary scales.

The initial state can be defined globally or locally via satellite data and according to the sectors considered. This makes it possible to take into account the localized impact in terms of changes in land use and the activity of a company if it is in a very rich biome.

As for the final state, this is defined in a normative way activity by activity (total artificialization for construction, impoverishment of biodiversity by intensive agriculture, exploitation etc.).

3.5 MSA and km².MSA: initial and final MSA values

For each pressure, impacts are therefore defined and calculated through damage functions. This is achieved by defining an initial state of biodiversity on a global scale (initial MSA) and a final state on a local scale (final MSA). This loss of biodiversity between two states (delta MSA) is then multiplied by an area. The area will depend on the volume of activities of a company and the severity of the pressure on biodiversity.

4 CBF: range of results delivered

4.1 Absolute metric

The CBF as an absolute metric is a result expressed in $-km^2.MSA$ reflecting the annual biodiversity footprint of an entity.

4.2 Indicators

For each impact, an indicator is computed as the ratio of the impact, expressed as a relative impact, and another metric (see list below). It allows comparison between entities and its peers within the same sector. Iceberg Data Lab calculates 4 different financial ratio with the CBF :

- Capital Employed: This ratio assesses the additional biodiversity loss per €M of additional capital used by the entity ;
- Turnover: This ratio assesses the biodiversity loss per €M of revenues of the entity ;
- Enterprise Value: This ratio, when multiplied by the €M invested in the company, assesses the biodiversity loss attributed to the investor ;
- Main services: This ratio assesses the biodiversity loss per unit of commodities or services provided by the entityy.

4.3 Scores

A CBF Score, on a range from 1 (best or most reduced impact on Biodiversity) to 6 (worst or most important impact on Biodiversity), is provided and used for running high-level screening for portfolio exclusion and allows comparison to the peers within the same sector.

The score is allocated based on the CBF Financial Indicator and reflects the relative performance of an issuer compared to its peers in a designated sector or sub-sector.

4.4 Positive Impact

At this stage, the contribution to Positive Impact will be approached through the :

- **“Reduced Impact”**
- **“Avoided Impact”**
- **“Compensated Impact”**

Each one of this impact score will be **expressed in + km^2.MSA**.

The **“Reduced Impact”** can be defined as the reduction of impact on biodiversity of a company or financial institution's over time. The reduction can be calculated between two years for which analyses have been completed and for which data is available. The “Reduced Impact” part is already implemented into our internal Wunderpus model.

The **“Avoided Impact”** is defined as the impact on biodiversity that a company or financial institution will have avoided over time compared to a baseline scenario established for the biodiversity and for each main sector. The methodology will be based primarily on that developed for the SB2A metric. The first results are available starting from 2023.

The **“Compensated Impact”** will cover efforts of positive land transformation, whether it is within a corporate’s own operations or through offset projects. The development of the methodology is completed, and the implementation of the indicator is underway. The first results will be available in 2023.

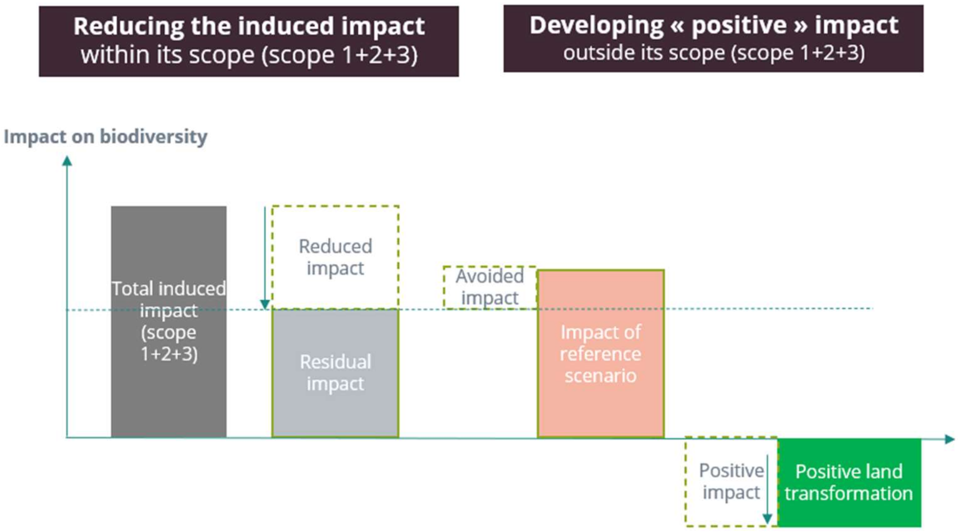

Figure 10: Illustration of the different components of the Positive Impact in the CBF methodology.

4.5 Data Quality Level

With each data point, a Data Quality Level Indicator (DQL) is calculated and based on the input used for the calculation. This shows the sources used for the calculation and the transparency level of the analysed entity or asset. This indicator therefore reflects the degree of uncertainty of the final result.
Five levels of input data quality are available:

- DQL of 1: Environmental data reported by companies are considered as best ;
- DQL of 2: Environmental data reported by companies are considered as best ;
- DQL of 3: If only sales are reported, the volumes are modelled in our customized Input/Output model;
- DQL of 4: When no data is available, a biodiversity footprint is modelled from sectoral average.

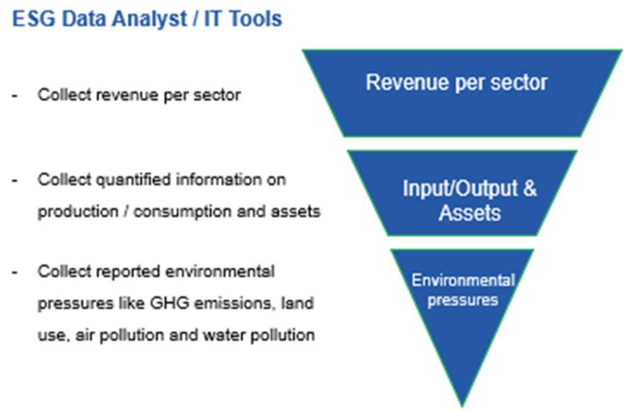

Figure 11: Data collection pyramid for adopting the best available data approach.

5 Sectoral specificities on most material sectors

Agri-Food & Tobacco
The Agri-food and Tobacco sectors stand out with a high land use in their upstream value chain. The land use is based on agricultural commodities or processed food. The land use for one ton of agricultural commodities depends on its country of origin and the yield in the corresponding country and year.

Power
The main impact in the sector comes from GHG emissions.

Forest & Paper
The main impact in this sector comes from the land use (forest harvesting) due to the supply chain of pulp and paper manufacturing. Different levels of impacts are modelled depending on the nature of the forest management.

Mining & Metals
The Metals & Mining sector has a direct and significant biodiversity impact mainly arising from the release of toxic compounds and land use. The Transformational Land Use is an important pressure in this sector because it depletes the area's resources and to keep the same extraction level, new areas need constantly to be transformed.
The manufacturing of metals requires the energy-intensive processing of large amounts of ores which emits GHG and creates tailings, sludge, and toxic waste, next to the visible impact in the natural landscape.
In case of the Coal mining, GHG emissions are also a main contributor to the biodiversity footprint due to the GHG emitted during the combustion of the coal.

Industrial equipment
The main material impact of the sector comes from the final use of industrial equipment. Indeed, most industrial equipment (such as engines, machinery, generators, ovens…) are very energy-intensive and they mainly are powered by fossil fuels. Hence, the GHG emissions tend to be the main impact of the sector. Additionally, the sector has an impact on biodiversity as industrial equipment manufacturing requires a great deal of metals which leads to water and soil pollution (see Mining & Metals).

Automotive & Logistics
The most material impact arises from the upstream value chain through the change of land use due to the sourcing of parts and raw materials to manufacture vehicles. Another important material impact are the GHG emissions and air pollution that arise from the final use of vehicles where fossil fuels are by far the main energy source.

Materials
The Materials sector and its impacts consists mostly of companies manufacturing cement and other binding materials for use in construction. Raw materials such as limestone and gypsum are often sourced from quarries which carry significant land use and land transformation impacts, and the transformation of raw materials into clinker requires vast amounts of energy from energy sources with high energy densities and releases high amounts of GHGs through the decarbonation process.

Financial services
The capital provided, in the form of financing and investment, has an indirect impact and is the most material impact (scope 3 downstream). The difference between constituents arises from the specificity of their sectoral allocation.

Electronics
The Electronics sector has an impact on biodiversity mainly arising from the upstream value chain through the land used for the extraction of raw materials needed for the manufacture of electronic devices.
Another material driver of the impact on biodiversity arises from GHG emissions induced by the electricity needed during the use phase of devices, as the world electricity mix still heavily relies on fossil fuels.

Transportation
The transportation sector is divided into 4 means of transport: road, rail, sea, and air and 3 segments: equipment manufacturers, infrastructures operators and fleet operators.
Land fragmentation is a major impact in the road transportation sector, due to the impact of infrastructures that split natural habitats like forests or grassland.
On the other hand, air and sea transportation main impacts come from the GHG emission and air pollution related to use phase of vehicles

Pharmaceutical
The pharmaceutical sector comprises companies manufacturing basic pharmaceutical products and medical supplies. The main impact of basic pharmaceutical products comes from water pollution downstream, related to their high toxicity.
For manufacturers of medical supplies and equipment, the main impact comes from the raw materials used (metals, plastic, textile, etc.).

Chemicals
The causes of the impact on biodiversity in the chemical sector differ greatly depending on the main activity. For producers of pesticides and other agricultural inputs, the impact arises from water pollution related to the use of such products. Companies producing plastics also have an impact on water pollution through plastic entanglement as 5% of plastic produced ends up in the ocean.
The main impact of manufacturers of basic chemical products comes from the Change of Land Use related to their raw materials (proteins, alcohol, etc.)

Internet & Data
The Internet & Data sector has an impact on biodiversity arising mainly from GHG emissions across the whole value chain:

- through scope 3 downstream emissions coming from online users' use of internet & data services
- through scope 2 emissions induced during the operation of data centres.

Building products
The impact of Building Products are due to the Change of Land Use for raw material extraction - mostly stone, sand, and other aggregates.
The impacts of chemicals produced upstream on freshwater sources and ecosystems are also significant.
Finally, carbon emissions represent around a quarter of the overall impact in the sector due to the need for smelting, drying, and heating during the manufacturing phase of products.

Construction & Real Estate

The Construction and Real Estate sector's most notable impacts on biodiversity are induced by the land and energy footprints of buildings. The disruptive direct and indirect impacts on habitats and ecosystems for sourcing raw materials in quarries are also significant – with new building construction in non-urban settings typically leading to a higher negative impact on the surrounding Biodiversity.

Hotel and accommodation

Overall, the hotel and accommodation sector has a limited impact on biodiversity. Its main contributors are the Change of Land Use due to the upstream food supply chain, the occupational land use of properties and GHG emissions from their energy consumption.

Household goods

The household goods sector comprises companies manufacturing products intended for end use by households.

The sector's impacts are the highest in the raw material extraction and manufacturing stages, where large quantities of metal, wood and stone are extracted, transported and transformed - which often implies land transformation in rural areas. For some goods, the use phase carbon emissions also present high impacts - particularly those intended for space heating and cooling.

Textiles

The largest biodiversity impact of the textile sector arises from the land occupation, mostly in the supply chain, related to raw materials used to manufacture clothing. Animal-related fabrics such as leather or fur are the most material commodity, due to the breeding and feeding of livestock. Cotton also has a significant impact on land occupation and soil degradation.

6 Methodological bias and limits

The CBF covers the most material biodiversity impacts, and the model is continuously improved. All material biodiversity impacts calculated are supported by robust scientific frameworks (damage functions, pressure factors).

However, there are methodological bias and limits to the CBF methodology, the most important ones being listed below:

- the CBF covers only terrestrial biodiversity and partially marine biodiversity, which are in the scope of many inventories, reviews, and damage functions ;
- the CBF is limited by data availability. Production, consumption, and prices are needed for the Input/Output model and when national sectoral data lack, regional or global data are used

Some pressure factors are not modelled yet, due to the lack of robust models and will be developed over time:

- Invasive species: The introduction and spread of invasive species threatens biodiversity by intruding the habitat of native species. To model this impact, more data of species distribution and movements due to human activities are needed. Further, the impact of introduced species varies according to the species, which cannot be modelled with existing data and limit the possibility to quantify their biodiversity impact.
- Resource consumption: The use of natural resources can have an impact on local biodiversity, which depends on factors such as resource availability in the region, consumption, and renewal rate and on dependencies of species on the concerned resource. More research and data are needed on these issues to implement a quantitative approach.

7 Future developments

The following impacts and indicators are also planned :

- The methodology development of the Invasive species and Water stress pressures into the model

8 Methodology benchmark

The CBF was developed to be used by financial institutions to report and manage their impact on Biodiversity and show some advantages vs other quantitative or qualitative approaches.

Comprehensiveness:
The CBF performs a products-based analysis and assesses their impact throughout the value chain of a Corporate. The CBF uses a very granular Input/Output model, which is regularly improved and updated based on various databases and research. In each sector the most material impacts are assessed.

Additionally, on top of modelled data the CBF uses reported or extrapolated data from company reports and other publicly available information. This allows one to get a very company-specific approach, which is more robust than the approaches based on sectoral averages, which fell short of appraising the performance of corporates' products and processes.

Similarly, the CBF uses a Life-Cycle-Assessment approach, calculating the impact throughout a value chain. This ensures that the most material impacts of a company are factored in, even if they are located upstream or downstream of its own operations.

Science-based:
The CBF is currently developed since 2019 by a team of environmental and modelling experts and expanded in partnership with the environmental expertise of I Care, an environmental consultancy firm, which steered the expansion of the methodology to all sectors in 2020, leveraging on its own biodiversity expertise.

The methodology and any new development are supervised by a Scientific Committee to ensure the quality and the relevance of the CBF. The role of the Scientific Committee is to advise on the key scientific pillar of the methodology, the latest scientific developments and its alignment with best available resources and methodology to account for Biodiversity impacts.

Actionable and recognized:
The CBF was developed by financial professionals to serve the needs of financial institutions with data solutions that are fit to their constraints (auditability, traceability, scalability).
It won the call for expression of interest[21] launched in September 2019 by Mirova, Axa IM, BNPP AM and Sycomore AM[22] and is used by major financial institutions to report on their biodiversity footprint[23].

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[21] https://www.axa-im.com/media-centre/axa-im-bnp-paribas-am-sycomore-am-and-mirova-launch-joint-initiative-to-develop-pioneering-tool-for-measuring-investment-impact-on-biodiversity

[22] https://www.mirova.com/en/news/iceberg-data-lab-icare-consult-selected-first-biodiversity-impact-measurement-tool

[23] See for instance, https://www.cnp.fr/en/cnp/content/download/9603/file/CNP-BILAN-RSE-2020-EN-01.pdf

In 2022, and related to the Article 29 of French Law, those major financial institutions published their first reporting on biodiversity[24, 25].

Comparability / Comparison:
The use of indicators allows the comparison between different actors / peers either in their sector or in the investment universe.

Public Benchmarks of other biodiversity impact methodologies
The CBF has been reviewed and compared with other methodologies by several multilateral organizations:

- The EU Business for Biodiversity platform, whose report can be accessed at: https://ec.europa.eu/environment/biodiversity/business/tools-and-resources/index_en.htm

- The Finance for Biodiversity Pledge launched the 2nd edition of the "Guide on biodiversity measurement approaches": https://www.financeforbiodiversity.org/wp-content/uploads/Finance-for-Biodiversity_Guide-on-biodiversity-measurement-approaches_2nd-edition.pdf

- The Partnership for Biodiversity Accounting Financials (PBAF) launched the "PBAF Standard v 2022": https://pbafglobal.com/files/downloads/PBAF_OA2022.pdf

- WWF in their report "Assessing Portfolio Impacts Tools to Measure Biodiversity and SDG Footprints of Financial Portfolios" accessible at: https://wwfint.awsassets.panda.org/downloads/wwf_assessing_portfolio_impacts_final.pdf

Contact and information:
www.icebergdatalab.com
contact@icebergdatalab.com

[24] BNP Paribas Asset Management, SUSTAINABLE BY NATURE SEQUEL: OUR PORTFOLIO BIODIVERSITY FOOTPRINT, June 2022: https://docfinder.bnpparibas-am.com/api/files/60B8656F-6A6F-4A35-9244-A997DCCB59FD

[25] Axa Group, Climate and Biodiversity Report Accelerating Transition, June 2022: https://www-axa-com.cdn.axa-contento-118412.eu/www-axa-com/3989afa7-966b-40b4-9280-c57c7b82191a_AXA-2022_Climate-and-Biodiversity-report.pdf