Biodiversity Counts

A novel solution to measure and monetize biodiversity impacts

Eco Intelligent Growth, Grupo Construcía, Foundation for Sustainable Development

Authors

Eco Intelligent Growth (EIG) is the consulting firm of Grupo Construcía that supports companies and organizations in their transformation toward positive and regenerative impact through circular economy, sustainability, and innovation. Inspired by nature's model of abundance—where waste becomes a resource—it focuses on creating solutions that not only reduce negative impact but also generate benefits for people, ecosystems, and business.

EIG is accredited to perform the assessment of products against the Cradle to Cradle Certified® Products Program since 2013.

Grupo Construcía is an ecosystem of companies aiming to transform construction and real estate into positive activities to humans and the environment by the circular economy. Its four companies operate along the value chain—from investment to product chemistry. Currently, it includes:

- **Eco Intelligent Growth**, Consultancy.
- **Construcía**, Circular construction.
- **Construcía Instalaciones,** Mechanical, electrical and plumbing.
- **Circular Capital**, Real estate development and impact investment management.

At the **Foundation for Sustainable Development** (FSD) we support the conservation and sustainable use of natural ecosystems since 2000. We aim to make nature count on balance sheets and decision-making and build knowledge and stimulate awareness of the ways in which people benefit from and interact with nature. The Ecosystem Services Valuation Database (ESVD) and our expertise in nature conservation, ecosystem services and monetary valuation allows us to provide valuable guidance on these critical issues, driving effective strategies and solutions that support a healthier, more sustainable future.

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01. Executive Summary

The global biodiversity crisis, fueled by human activities such as habitat destruction, pollution, and climate change, poses significant risks to ecosystems, economies, and societies. Organizations face growing regulatory and consumer pressures to address biodiversity impacts, yet challenges such as the complexity of ecosystems, fragmented data, and the lack of standardized metrics hinder progress.

In response, Eco Intelligent Growth (EIG) and Grupo Construcía (GC), in collaboration with KPMG Netherlands and the Foundation for Sustainable Development (FSD), developed the 'Biodiversity Counts' solution. **This innovative solution measures and assigns economic value to biodiversity impacts across supply chains.** 'Biodiversity Counts' bridges critical gaps in existing methodologies by incorporating a broader range of pressures, including water availability and ecotoxicity, and offering high-resolution, context-sensitive analyses.

Comparative evaluations show that 'Biodiversity Counts' delivers results comparable to alternative tools but surpasses them in capturing nuanced biophysical and socio-economic contexts. For example, while alternative tools focus on biome-level impacts, 'Biodiversity Counts' detailed approach identifies unaccounted biodiversity costs which would increase current retail price by 10–17%. It also highlights the importance of indirect supply chain impacts, which often constitute a significant share of total biodiversity loss. In one case, optimizing wood sourcing for a housing project reduced biodiversity-related costs by 80%, from €500,000 to €100,000.

Ultimately, by introducing a pioneering methodology for quantifying biodiversity impacts in monetary terms, 'Biodiversity Counts' **empowers companies, policy makers and investors to address hidden environmental costs, prioritize sustainable practices, and comply with evolving regulatory frameworks such as the CSRD and EU Taxonomy.** Moreover, nature-positive investments, such as ecosystem restoration, yield substantial economic benefits—€8 to €38 for every €1 spent. Through solutions like 'Biodiversity Counts', companies can align with sustainability goals, mitigate risks, and contribute to closing the global biodiversity financing gap.

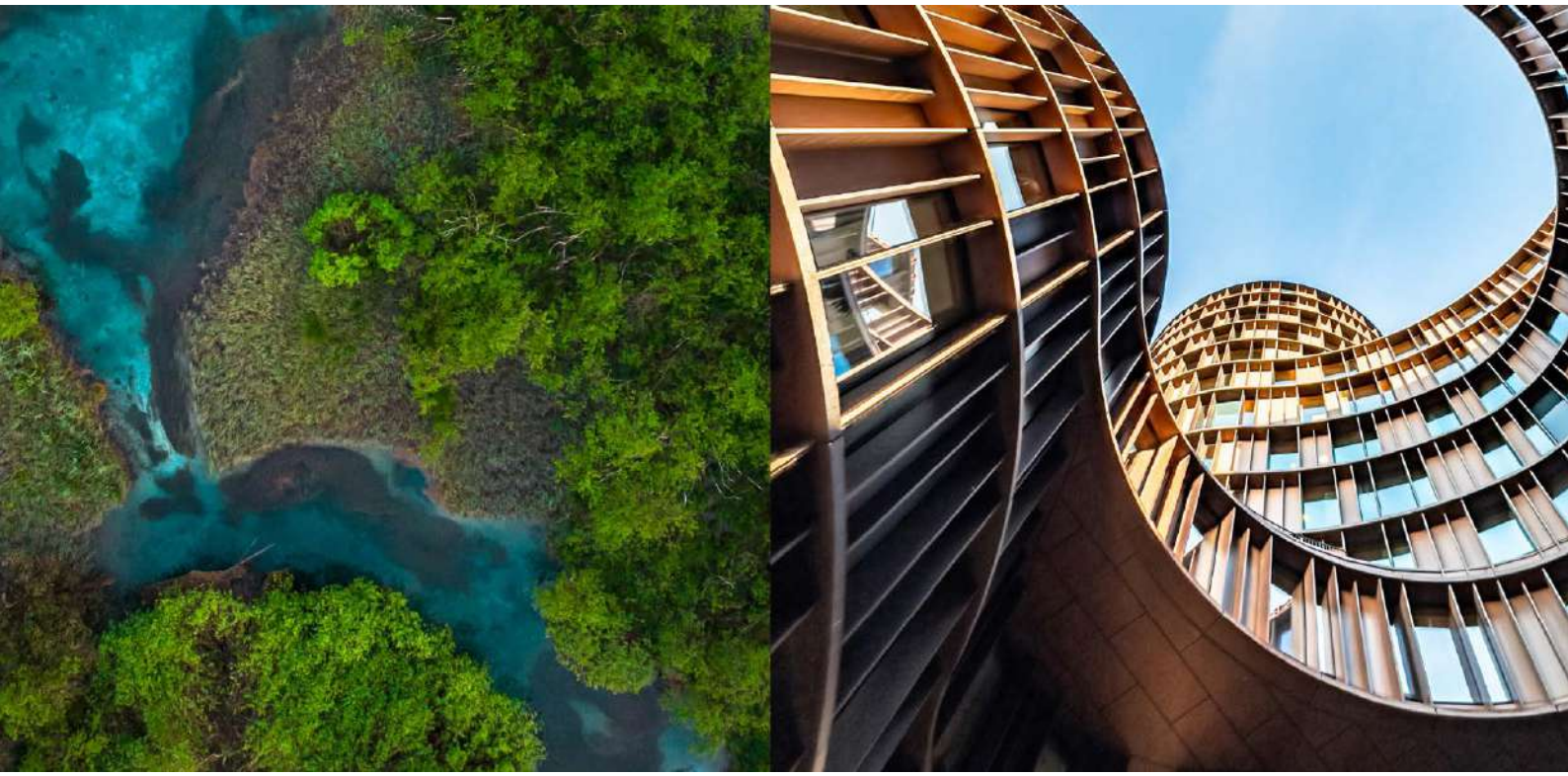
02. Introduction

The current state of biodiversity loss is alarming, with over a million species facing extinction due to human activities, including habitat destruction, pollution, and climate change (IPBES, 2019). This unprecedented decline not only threatens ecosystems but also poses significant risks to companies and other organisations, all of which are virtually deeply reliant on natural resources and ecosystem services in both direct (e.g., direct use of resources like fresh water and water provisioning services) and indirect ways (impacts associated with their complex and vast value chains).

Globally, the nature and biodiversity conservation movement gained traction with the 1992 Earth Summit in Rio de Janeiro, leading to the landmark Convention on Biological Diversity (CBD). In 2010, the CBD adopted the Aichi Biodiversity Targets, setting global conservation goals for the next decade and reinforcing the role of businesses in biodiversity efforts. This involvement was further strengthened by the Kunming-Montreal Global Biodiversity Framework, adopted in 2022, which guides global conservation actions up to 2030 and beyond, with the ultimate goal of achieving a world living in harmony with nature by 2050. **The framework underscores the importance of corporate responsibility in addressing biodiversity loss, recognizing that private sector engagement is essential to complement public initiatives in achieving ambitious conservation goals.** This recognition has been translated into regulations that not only require businesses to mitigate their negative impacts on biodiversity but also to actively contribute to conservation efforts.

As an example, the European Union has implemented a regulatory package speared by the Corporate Sustainability Reporting Directive (CSRD) and its European Sustainability Reporting Standards (ESRS) together with the EU Taxonomy, introducing stricter requirements for companies based and/or active in the EU to disclose their impacts, dependencies, risks and opportunities related to biodiversity. The EU Taxonomy, however, goes beyond disclosure—it aims to scale finance for sustainable economic activities and redirect capital flows toward environmentally sustainable investments. This regulatory shift compels these companies to integrate biodiversity considerations into their core strategies, highlighting the growing recognition of biodiversity impacts and dependencies and their role in corporate sustainability.

Beyond regulatory compliance, a robust nature and biodiversity strategy serves a dual purpose. On one hand, it helps mitigate risks associated with business dependencies on nature, such as resource scarcity or supply chain disruptions. On the other hand, it creates significant opportunities, such as attracting new financial flows through investments in nature-positive initiatives and sustainable practices. **These risks and opportunities are interconnected and can be effectively managed using frameworks like the Science-Based Targets for Nature (SBTN) mitigation hierarchy, which emphasizes avoiding, reducing, and restoring impacts.** Adopting a double materiality perspective ensures that companies and other organisations address both their financial dependencies on nature and their broader impacts on ecosystems, aligning with leading frameworks such as the Taskforce on Nature-related Financial Disclosures (TNFD). By demonstrating a strong commitment to nature and biodiversity, and internalizing the impacts companies have on them, organisations can strengthen their market position and ensure their operations remain resilient and adaptive to changing environmental and market conditions and regulations.



Organisations however struggle to internalize biodiversity impacts due to the complexity of ecosystems, lack of standardized metrics, and fragmented or outdated data. Biodiversity impacts vary by location, requiring tailored approaches, while integrating these considerations demands interdisciplinary expertise many organisations lack. Additionally, traditional business models prioritize short-term gains over long-term sustainability. These challenges hinder organisations from effectively adopting sustainable biodiversity strategies.

To help organisations overcome these obstacles, (EIG) and Grupo Construcía (GC), in collaboration with KPMG Netherlands and the Foundation for Sustainable Development (FSD), has developed the **'Biodiversity Counts', an innovative solution to measure and assign economic value the biodiversity impacts associated with the activities of organisations and final consumers.**

This paper introduces 'Biodiversity Counts', focusing on the specific impacts of business activities on biodiversity. It simplifies the complexity of the issue, aiming to provide readers with practical takeaways to evaluate their own biodiversity impacts effectively.

The document is the fruit of a collaboration amongst private consultancy companies (EIG and KPMG Netherlands), the industry (GC, Circular Capital and Andreu World), and a research consultancy on monetary valuation of ecosystem services (FSD). The initiative of EIG and GC to create a methodology to assess and value the impacts of organisations to biodiversity found great enthusiasm within the KPMG and FSD teams. KPMG supported EIG and GC to develop the foundation for this methodology by connecting several long-standing research models. FSD collaborated with the other parties by providing their expertise in assigning economic value to ecosystem services, reviewing the functioning of the solution and granting commercial access to the Ecosystem Services Valuation database (ESVD), the most comprehensive database on this subject. Their inputs and recommendation on the use of the database have been key for the creation of the proposed solution. **Circular Capital and Andreu World have offered to pilot the use of 'Biodiversity Counts'.**

03. The Importance of Valuing Biodiversity

One approach to assess the economic importance of biodiversity is to apply the concept of ecosystem services (ES), which are the benefits that humans receive from nature. The concept highlights the intricate connection and dependence of our societies and economies on ecosystems, and their contribution to human welfare. Biodiversity affects the provision of ES at multiple levels: as an intermediate service that underpins the resilience and capacity of ecosystems to provide ES; and as an input into production (e.g. genetic information used in the development of medicines, a diversity of grass and flower species to increase water holder capacity or pollination for food production) and consumption (e.g. nature-based recreation and tourism) (Mace et al., 2012). This approach is particularly effective because it translates the complex ecological functions of biodiversity and nature into tangible and quantifiable benefits, making it easier for stakeholders to understand, value, and integrate biodiversity into decision-making processes (Costanza et al., 1997; Daily et al., 1997).

The consequences of biodiversity loss have largely been ignored on investment balance sheets or annual reports because the costs are generally not incurred by the investor and often only become visible in the future. The Dasgupta review, The Economics of Biodiversity (2021), elaborated on the roots of this problem:

> **"The true value of the various goods and services it [nature] provides, is not reflected in market prices because much of it is open to all at no monetary charge. These pricing distortions have led us to invest relatively more in other assets, such as produced capital, and underinvest in our natural assets. Moreover, aspects of nature are mobile; some are invisible, such as in the soils; and many are silent. These features mean that the effects of many of our actions on ourselves and others, including our descendants, are hard to trace and go unaccounted for, giving rise to widespread 'externalities' and making it hard for markets to function well (Dasgupta 2021, p.2)."**

Biodiversity and nature loss are increasingly becoming a material topic for businesses and the financial sector. Failing to account for the full value of nature has significant negative impacts on society and companies, including financial institutions. This growing recognition is reflected in a 2023 report by the European Central Bank (ECB) (Boldrini, 2023), which estimated that in the Eurozone, approximately 75% of companies (3 million out of 4 million investigated) are highly dependent on at least one ecosystem service. A more specific example comes from the Dutch Central Bank and the Netherlands Environmental Assessment Agency (PBL), which assessed the risks facing the Dutch financial sector in their report Indebted to Nature (Van Toor et al., 2020). The report revealed that Dutch financial institutions worldwide have EUR 510 billion in exposure through companies with a high dependency on one or more ecosystem services.

This highlights the increased interest from the financial and business sectors to account for the risks of nature loss. Assessing the extent of the different risks and opportunities requires insights in the impacts and dependencies of business and finance sector on nature. In the past years, important steps have been made in assessing these impacts and dependencies. Different concepts, initiatives, guidance documents, and frameworks on these topics have been published. Examples include:

- **TNFD`s LEAP approach (Locate, Evaluate, Assess and Prepare).**
- **The Global Biodiversity Framework (GBF).**
- **The Partnership for Biodiversity Accounting Financials (PBAF) Standard on Dependencies.**
- **The Network for Greening the Financial System (NGFS)'s conceptual framework.**
- **The mitigation hierarchy.**

Although there is a surge in interest and research, the TNFD states that the business sector at large is currently not adequately assessing or disclosing nature-related risks (TNFD, 2023) and there are concerns that the complexity and scale of assessment may limit action (Linsey et al., 2023). Despite these challenges, the need for measuring impacts and dependencies on nature and biodiversity is clear.

The economic valuation of biodiversity and related ecosystem services helps to translate ecological information into economic and policy-relatable terms. Monetary valuation of ecosystem services measures the net benefit that people derive from a good or service, whether or not there is a market and monetary transaction. Economic valuation is one way to quantify and communicate the importance of something (e.g., environmental damage, changes in resource availability, ecosystem services etc.) to decision makers, and is complementary to other forms of information (e.g., bio-physical indicators and social impacts). The advantage of economic valuation is that it conveys the importance of environmental change directly in terms of human welfare and uses a common unit of account (i.e., money) so that values can be directly compared across other goods, services, investments and impacts in the economy. **To prevent further biodiversity loss and ecosystem degradation, it becomes crucial to systematically incorporate the full value of ES into the daily decision-making processes of governments, companies, and individuals alike (Daily and Ruckelshaus, 2022).**

A common argument that arises with regards to the monetary valuation of nature is that it commodifies nature (Gómez-Baggethun & Ruiz-Pérez, 2011), thereby neglecting other frameworks and units to value nature such as intrinsic, relational, cultural or ecological frameworks. Ecosystem services and their subsequent monetary valuation aims to be additive, meaning that other frameworks can exist and be utilized in a collaborative fashion. It is key to note that the goal of monetary valuation is not to price, but to value nature. **Monetary valuation thereby becomes a way of communicating, a common language to indicate the importance of nature for economies, societies and individuals in a universally understood metric like, for example, currencies (USD, EUR, etc.).** Understanding the dependencies and impacts in monetary terms can be fruitful in understanding the implications and consequences of nature and biodiversity loss for public and private decision-making by introducing comparability, incorporation of local context and easy integration in existing accounting systems (Value Balancing Alliance, 2022).

04. Introducing 'Biodiversity Counts'

Solution overview

The 'Biodiversity Counts' solution provides a detailed, transparent, and context-sensitive approach to the economic valuation of biodiversity (see Figure 1). It goes beyond conventional assessments by addressing a broad range of environmental pressures, such as land use and transformation, eutrophication, acidification, water availability, and ecotoxicity, ensuring a **more complete impact analysis.** By leveraging high-resolution open data, 'Biodiversity Counts' **integrates the biophysical and socio-economic context at the coordinate level**, avoiding the uncertainties associated with generalized biome-level factors and offering more accurate information.

The solution addresses uncertainty using diverse prices for biodiversity damage based on valuation methods and ecosystem services, ensuring **in-depth interpretation and robust treatment of uncertainties**. It also reflects the non-linear relationships between ecosystem service values and biodiversity, enabling a **better representation of ecosystems** and capturing the true state of affected environments.

With a strong emphasis on **transparency and comparability**, 'Biodiversity Counts' provides clear and traceable results, making it easier to compare product versions and assess project outcomes confidently. This framework supports more informed decision-making for managing biodiversity impacts across value chains.

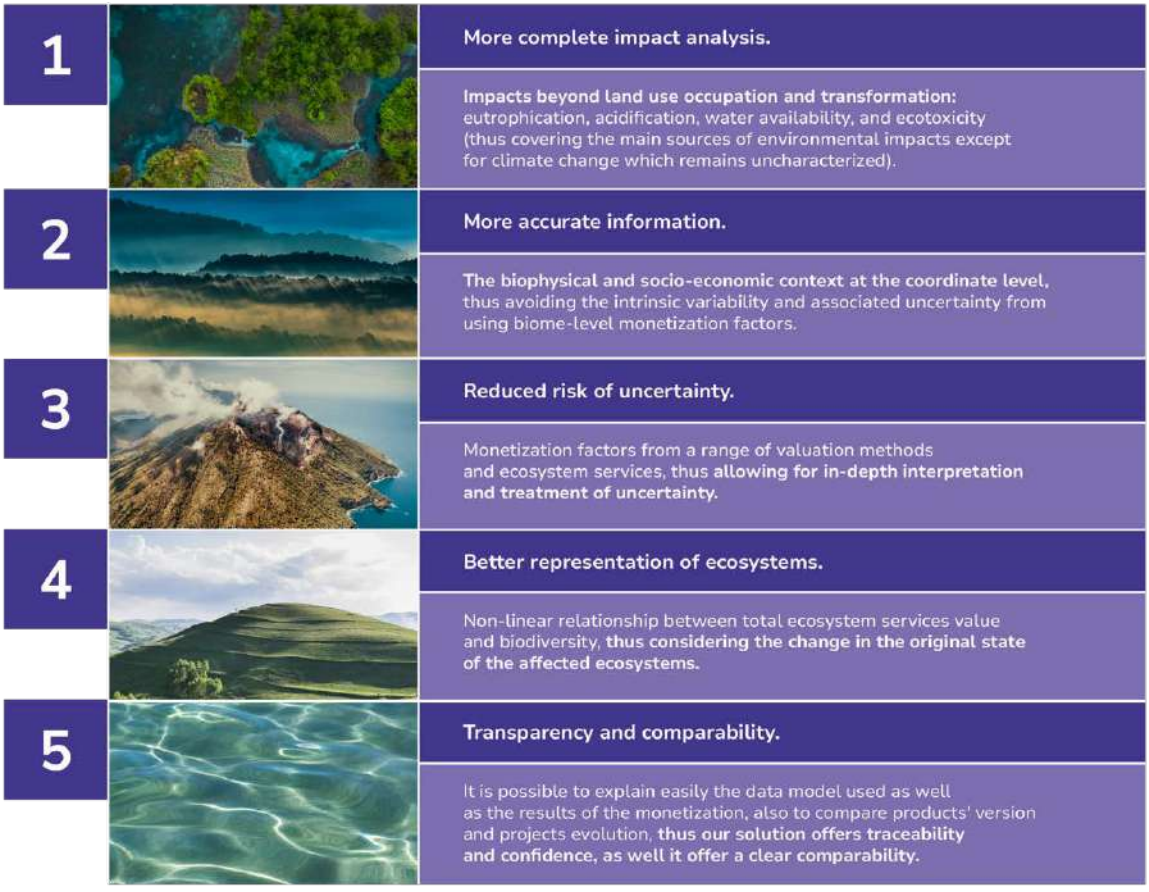


Figure 1. 'Biodiversity Counts' beyond the state-of-the-art.

Biodiversity footprints

Impacts on biodiversity are best measured using a life-cycle or footprint perspective to comprehensively account for the effects of production and consumption across supply chains, incorporating key aspects such as spatial and regional data and land-use practices (Marques et al., 2021). When focusing solely on direct effects, such as land use and transformation linked to specific projects, one risks neglecting the far-reaching indirect (also referred to as scope 3 impacts), systemic, and cumulative impacts that propagate through global supply chains, where the consumption of commodities can drive habitat destruction, biodiversity threats, and ecosystem degradation in potentially distant regions, offering an incomplete and misleading assessment of the complete biodiversity footprint (Lenzen et al., 2012). **Life Cycle Assessment (LCA) provides a comprehensive framework to evaluate both direct and indirect biodiversity impacts by analysing the entire life cycle of products, from resource extraction to disposal, integrating spatially explicit data when relevant.** Biodiversity impacts are generally calculated using Life Cycle Impact Assessments (LCIA) methods which translate full inventory results first into midpoint impacts and then endpoint impacts such as damage to ecosystems (see Figure 2. for an overview and Figure 3. for a specific example).

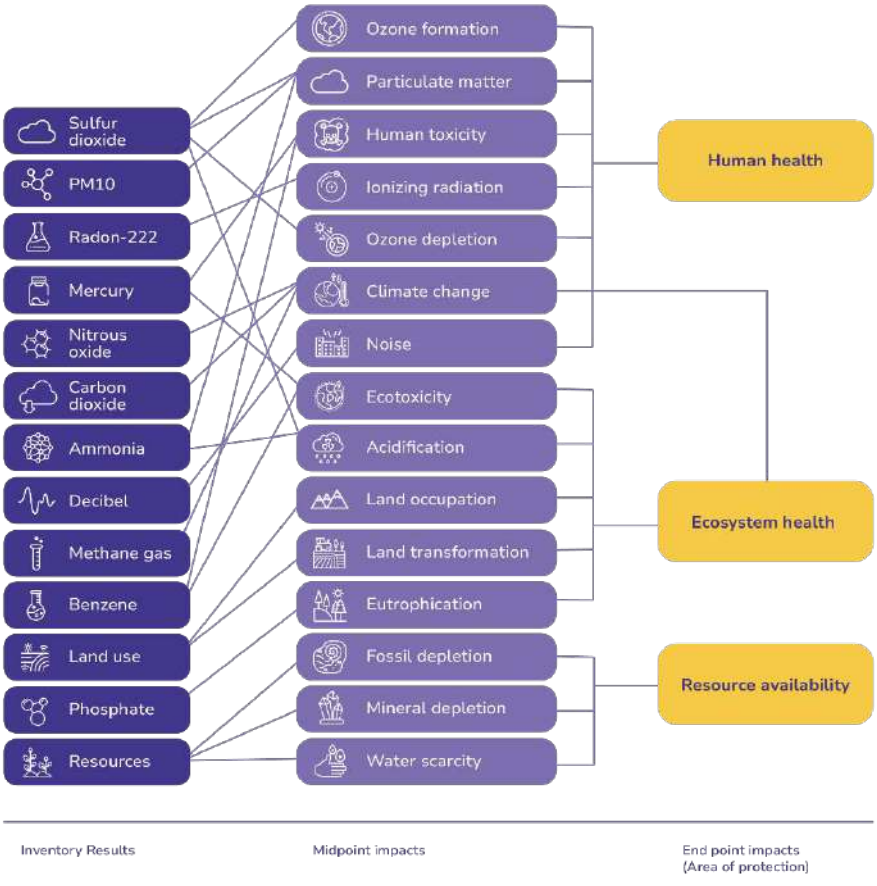


Figure 2. Impact pathways from inventory results to midpoint and endpoint impacts, adapted from: *Comparing of the external bearing wall using three cultural perspectives in the life cycle impact assessment - IOPscience*.

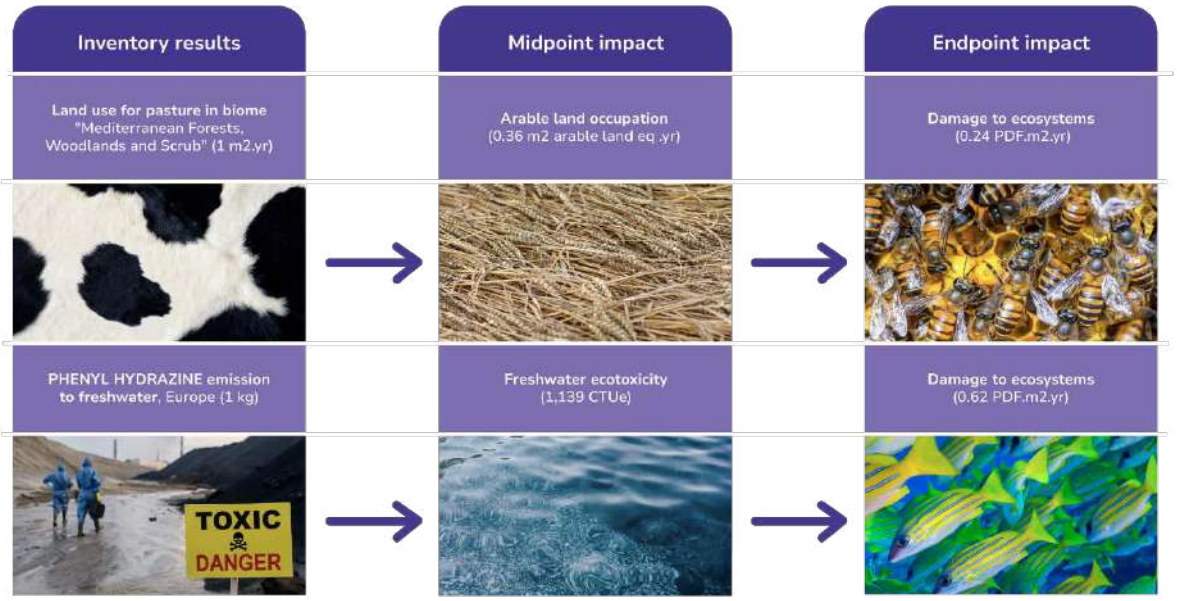


Figure 3. Impact pathways for land use and ecotoxicity. PDF: potentially disappeared fraction of species.

Some LCIA methods provide highly detailed spatial resolutions, ranging from global grid cells to biomes, watersheds, and regions, supported by advanced models designed to capture the intricate complexity of interactions within ecosystems. Examples of such methods include Impact World+, LC-IMPACT, and ReCiPe (Damiani et al., 2023). However, this level of detail is often underutilized in current economic valuation approaches, which are generally based on generic and/or narrowly scoped valuation factors (Nunes and van den Bergh, 2001; Ott et al., 2004; Galgani et al., 2023; IEF, 2024).

Key limitations of these approaches include a focus on land use and occupation pressures, and the application of valuation factors to aggregated and heterogeneous geographic units such as regions, biomes, and biotopes. Consequently, **the economic valuation step overlooks the spatial heterogeneity and ecological specificity of biodiversity impacts.**

Importance of geographical detail

Comprehensive geographical detail is essential for accurately capturing variations in ecosystem vulnerability, species sensitivity, and regional biodiversity priorities, as it accounts for the unique ecological contexts of different locations. This granularity enables precise assessment of local biodiversity pressures and the valuation of ecosystem services, reflecting site-specific conditions. By doing so, it mitigates the risks of oversimplified or generalized approaches that often underestimate the true ecological and economic value of biodiversity.

Additionally, **it is important to recognize that some species play disproportionately significant roles in ecosystem regulation.** These keystone species highlight the qualitative nature of ecosystem regulation and its critical influence on biodiversity. By incorporating this granularity, our tool ensures these ecological dynamics are effectively captured, making biodiversity assessments more precise and actionable.

Such detail is particularly crucial in areas with high levels of endemism or ecological significance, like biodiversity hotspots, where species or ecosystem losses can have disproportionately severe ecological and socio-economic impacts. **Accurate geographical granularity ensures these unique regions are appropriately considered in conservation planning, resource management, and policy decision-making, resulting in a more realistic and equitable framework for biodiversity valuation.**

To achieve this, **an appropriate LCIA method must integrate regionalization of environmental impacts, account for spatial variability in ecosystem vulnerability and biodiversity priorities, model site-specific impact pathways** (e.g., land use, freshwater use, emissions), leverage high-resolution global datasets, and assign higher sensitivity weights to biodiversity hotspots and regions with significant ecological importance.

Introducing 'Biodiversity Counts'

'Biodiversity Counts' is designed to overcome current shortcomings in biodiversity economic valuation approaches (see table 1). 'Biodiversity Counts' **provides a comprehensive framework for evaluating biodiversity impacts by integrating advanced metrics, a broader scope of pressures, and a dynamic approach to valuation.** It aims to align biophysical realities with socio-economic factors, delivering a more accurate, context-specific, and actionable understanding of biodiversity's economic value.

'Biodiversity Counts' is an evolution of the Lean2Cradle True Value concept, which **combines the principles from Lean Management, the Cradle to Cradle® philosophy, and KPMG's True Value methodology to promote sustainable and circular value creation.** It focuses on maximizing value, minimizing waste, and fostering resilience through regenerative design, continuous improvement, and the integration of societal, environmental, and financial considerations (Walrecht et al., 2020).

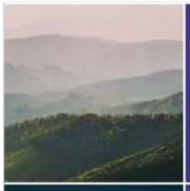
		Established approaches	Biodiversity Counts
	Biodiversity pressures	Focuses primarily on land occupation and transformation as the main pressures.	Considers a comprehensive set of pressures, including land occupation, transformation, eutrophication, acidification, water availability, and ecotoxicity.
	Biophysical and socioeconomic context	Relies on economic valuation factors aggregated at the country or biome level.	Employs native impact characterization factors at global grid cell, biome, watershed, and region levels. Incorporates economic valuation of impacts tailored to the biophysical and socio-economic context at a precise coordinate level for greater accuracy and relevance.
	Economic valuation factors	Derives values typically from restoration, opportunity, and/or compensation costs.	Incorporates a full spectrum of ecosystem services and diverse valuation methods for a holistic approach.
	Biodiversity valuation	Assumes a constant relationship between biophysical variables and economic valuation.	Establishes a dynamic relationship between biodiversity metrics and their economic value, reflecting nuanced and context-specific dependencies.

Table 1. Comparison between established approaches and 'Biodiversity Counts'.

'Biodiversity Counts' can precisely characterise and valuate the impacts related to the life-cycle of products, projects, organisations, and policies previously calculated using LCA. To fully exploit its potential, **value chain activities are strategically geolocalised by focusing on biodiversity impact hotspots**, such as tree cultivation and mining activities. Biodiversity impact hotspots are identified by analysing generic products and product categories using comprehensive databases such as ecoinvent (Weidema et al., 2013) and EXIOBASE (Stadler et al., 2018).

The underlying LCIA method is based on **Impact World+ (IW+)** (Bulle et al., 2019), which offers an **optimal combination of impact coverage, data availability and timeliness, and geographical detail with respect to alternative methods** (Damiani et al., 2023).

IW+ contains damage characterisation factors based on Potentially Disappeared Fraction of Species (PDF) for **8 impact categories (freshwater acidification, terrestrial acidification, freshwater ecotoxicity, freshwater eutrophication, marine eutrophication, land occupation, land transformation, and water availability)** based on 5 native geographical resolution scales (0.5° x 0.5° and 2° x 2.5° world grid cells, Olson biomes, watersheds, and world regions).

PDF measures the potential decline in species richness, encompassing relevant taxa within an ecosystem, due to harmful environmental factors, compared to species richness in pristine, undisturbed ecosystems. PDF is generally calculated over both spatial and temporal dimensions (e.g., PDF.m2.yr), with larger positive PDF values signifying a more substantial negative impact on biodiversity. Negative PDF values indicate positive impacts, such as those resulting from ecosystem restoration activities or land-use changes that enhance biodiversity and promote nature-positive outcomes.

There is currently no direct way to value biodiversity because its ecological, social, and non-market values are complex, interconnected, and difficult to quantify using traditional economic methods (Bartkowski, Lienhoop and Hansjürgens, 2015).

The proposed approach in 'Biodiversity Counts' is thus based on Total Ecosystem Service Value (TESV) as a proxy of biodiversity quality. TESV represents the aggregated monetary value of all ecosystem services provided by a given ecosystem, such as water provisioning and recreational services. This approach is based on the work of Maes and colleagues (2012), which analysed the relationship between TESV and various representations of biodiversity: Mean Species Abundance (MSA), forest tree species diversity, and relative surface area of the Natura 2000 network. While all three described positive spatial correlations, showing that TESV and biodiversity are strongly linked, MSA described the best spatial correlation. MSA measures local biodiversity intactness and is calculated based on the abundance of individual species under influence of a given pressure, compared to their abundance in an undisturbed situation (natural situation/reference).

MSA and PDF are closely related and complementary, and one can be interpreted as the inverse of the other under certain assumptions, so PDF = 1-MSA (Goedkoop, Rossberg and Dumont, 2023). 'Biodiversity Counts' therefore draws on the relationship between PDF and TESV to value biodiversity impacts. Specifically, by estimating the change in TESV associated with any given change in PDF. In other words, biodiversity loss (using MSA or PDF as proxies) can be translated to monetary units via changes in TESV.

Public economic valuations of ecosystem services are consistently and systematically integrated into the Ecosystem Services Valuation Database (ESVD) (Brander et al., 2024), the most comprehensive resource on this subject. The ESVD comprises over 10,000 value records derived from more than 1,000 studies spanning multiple biomes, ecosystem services, and geographic regions. Each record is detailed with multiple attributes, including biome, ecosystem type, ecosystem services provided, valuation methods, protection status, geographical coordinates, and normalized monetary values. Additionally, Mean Species Abundance (MSA) values from the GLOBIO4 database (Schipper et al., 2020) are incorporated into the ESVD framework. **The expanded ESVD serves as the foundation for training a series of regression models, with the model exhibiting the highest predictive accuracy selected as the optimal approach. This model relies on key predictors, including MSA and ecosystem type, to deliver superior performance. Using this regression model, the TESV can be estimated for specific ecosystem services and valuation methods based on the selected predictors.** This enables precise calculations of changes in TESV associated with variations in the original MSA values, offering insights into the impacts of activities on ecosystem services (see Figure 4).

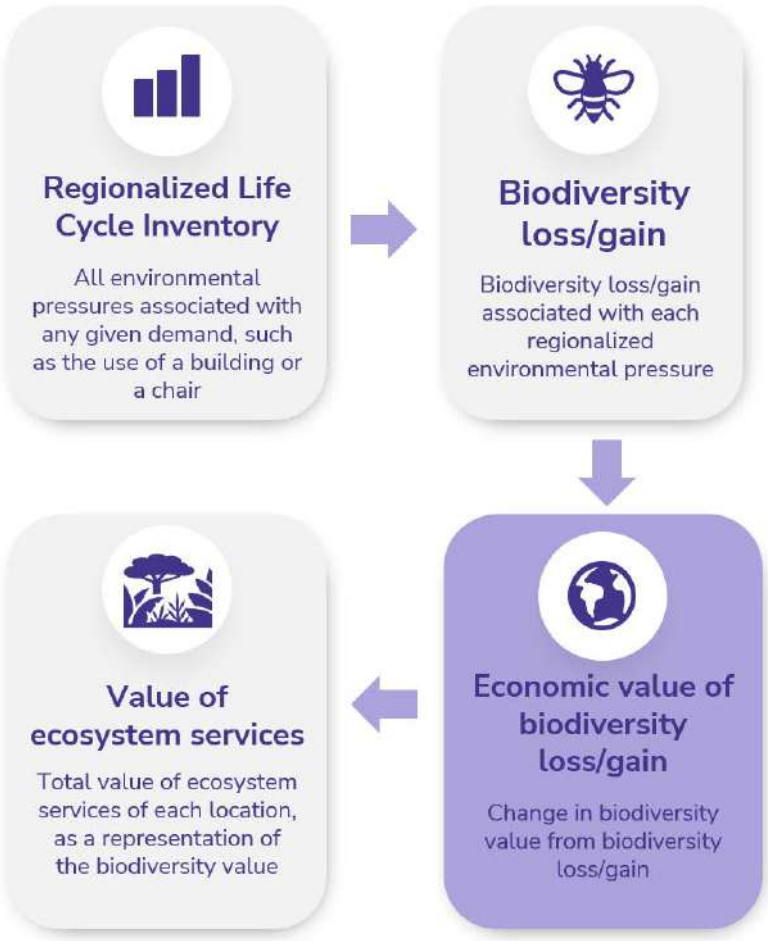


Figure 4. Overview of the 'Biodiversity Counts' model.

05.Case Studies

Introduction

'Biodiversity Counts' has been tested in case studies to ensure its effectiveness and alignment with real-world applications. It has helped to identify user needs, ensuring the solution addresses specific challenges faced by stakeholders. Pilots have refined functionality by testing the solution in diverse contexts and validating that outputs are accurate, reliable, and context-specific. They have also helped to correct language and communication, ensuring clarity and consistency across interdisciplinary fields. Additionally, piloting has highlighted data gaps, fostered stakeholder engagement, and demonstrated the solution's potential impact in improving biodiversity valuation and nature positive decision-making. These efforts have led to positive outcomes, such as enhanced accuracy in biodiversity impact assessments, improved stakeholder collaboration, and actionable insights that have informed nature-conscious practices and policies. Two distinct case studies have been selected: a housing construction project and a wood-based armchair. **These cases were chosen for their contrasting scopes and impacts—while the construction project addresses direct impacts from land use and transformation as well as multiple supply chains, the product-level analysis highlights indirect impacts across a specific supply chain.** Together, these complementary insights provide a comprehensive understanding of biodiversity impacts and potential actionable pathways.

The housing construction project is promoted by Circular Capital, a Spanish investment management firm that challenges the status quo of the construction ecosystem, associated industries, and real estate, pursuing positive impact for people, the planet, and companies. The project is located in the Spanish Mediterranean coastline and consists of 11 residential units designed for high environmental performance. Spanning a constructed surface of about 1,100 m², the project leveraged 'Biodiversity Counts' during the basic design phase to identify potential biodiversity impact hotspots. This analysis informed critical decisions regarding material selection and sourcing in later stages. Simulations were conducted to translate design measurements into physical quantities, such as material volumes and weights, resulting in the following simplified bill of quantities (in tons): cement (1,956), aluminium (4), glass (4), and wood (19). The scope of the assessment included raw material acquisition, transport to site, and land occupation and transformation during construction and use stage.

The wood-based armchair is manufactured by Andreu World, a Spanish company specializing in the design and manufacture of high-quality, sustainable seating and tables for both residential and public spaces, with a strong emphasis on craftsmanship and environmental responsibility. The armchair is designed with a total weight of approximately 7.5 kg, primarily constructed from ash wood, polypropylene, and aluminium, and manufactured in Spain. The scope of the assessment encompassed raw material acquisition, transport to the manufacturing site, energy use during production, and packaging. Raw material acquisition, particularly the logging activity associated with the wood components, was identified as a potential environmental impact hotspot. Geolocated data on logging activity was incorporated, with productivity metrics such as land and water resource use adjusted using primary data from the manufacturer. 'Biodiversity Counts' was applied to confirm and quantify these impact hotspots, providing critical insights into resource use and potential mitigation strategies through eco-design.

The data requirements for applying 'Biodiversity Counts' align closely with those typically needed for conducting a Life Cycle Assessment (LCA). These include essential inputs such as bills of materials, land use, energy consumption, and waste generation associated with a specific product or activity. Additionally, 'Biodiversity Counts' extends these requirements by incorporating detailed glocalization data for key activities, particularly those with direct impacts, such as landscaping or cultivation. This includes metrics related to land transformation as well as land and water productivity, ensuring a more precise and context-sensitive assessment of biodiversity impacts.

Results and Insights

Housing construction project

Based on the initial basic project assessment, this initiative was associated with a net biodiversity loss valued at approximately €500,000, with the majority of the impact concentrated in Canada (55%) and Spain (21%). In Spain, the impacts were nearly evenly distributed between direct effects, such as land use and site transformation during construction, and indirect effects from the extraction and processing of raw materials. Although wood products accounted for only 1% of the total weight, they were responsible for a striking 84% of the total biodiversity impact, primarily due to land occupation (see Figure 5 and Figure 6) significant driver of this biodiversity loss was the sourcing of wood products from areas with high biodiversity value, such as Canada. For instance, the value of one PDF lost in Canada is approximately €6.5, compared to just €0.2 in Spain. A notable feature of 'Biodiversity Counts' that explains this result is how it addresses missing data, such as the specific sourcing country or region. In this case, due to the project's lack of detailed information on the origin of wood products, 'Biodiversity Counts' is designed to assume the national market and randomized locations within each supplying country. As a result, some wood was assumed to originate from high-biodiversity-value locations in Canada. The valued biodiversity loss represents approximately 10% of the project's final retail price.

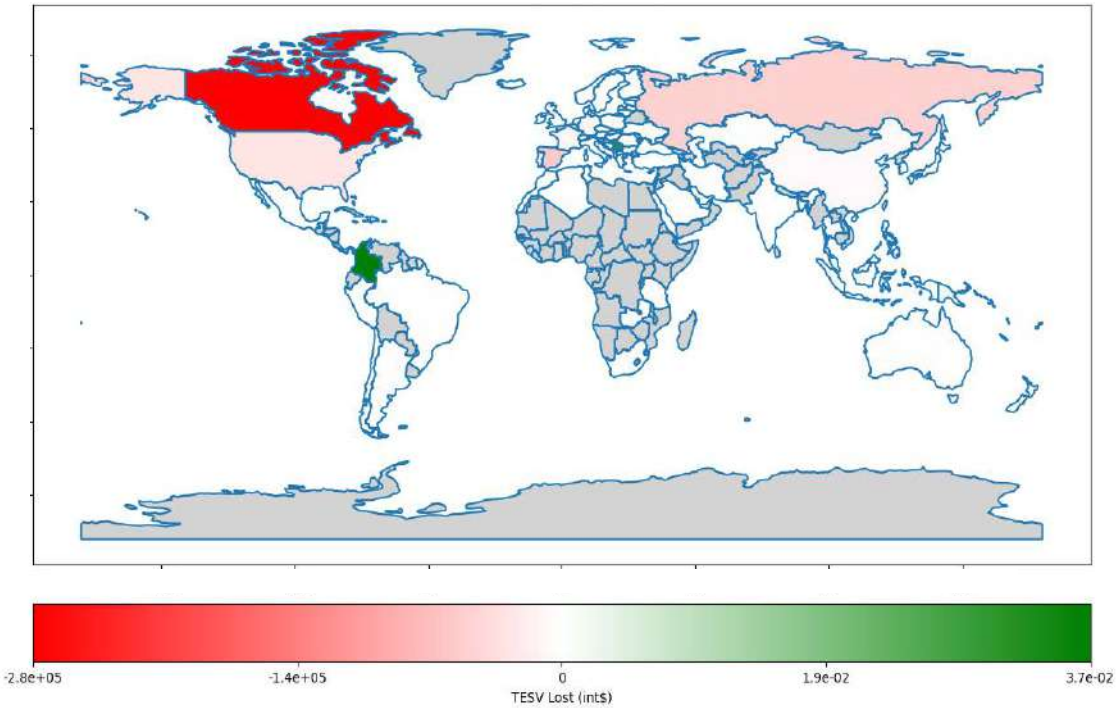


Figure *5.* Monetised biodiversity impact for the housing construction project by environmental driver, activity, and country.

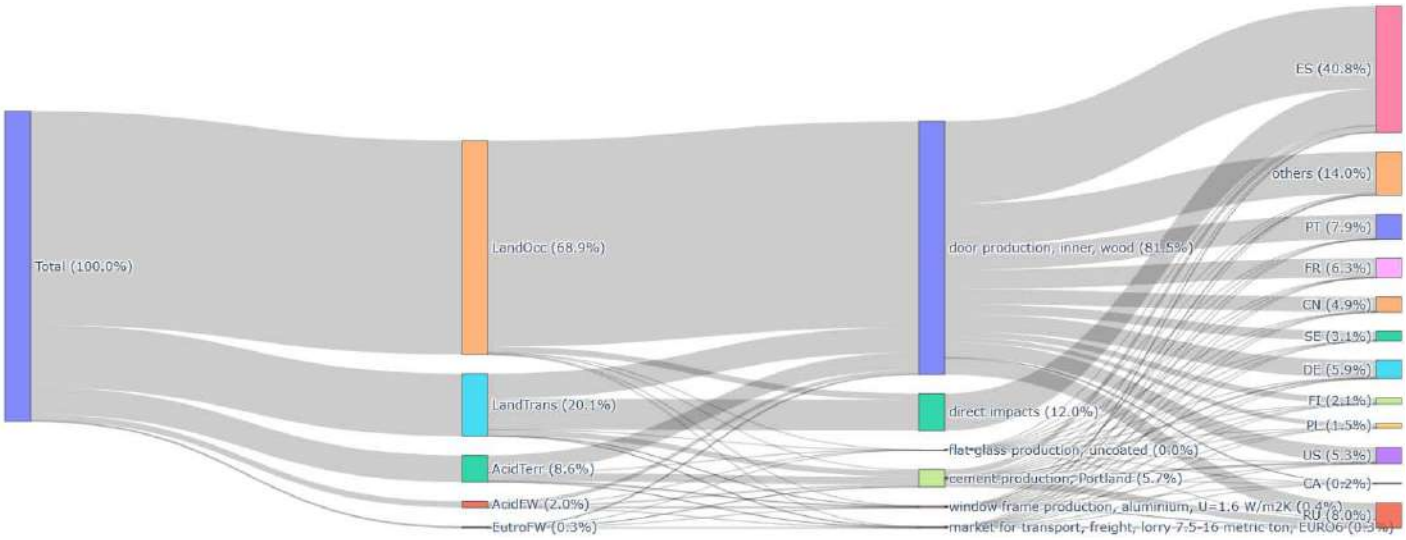


Figure 6. Source of monetised biodiversity impact by environmental driver, activity, and country.

Armchair

The analysed armchair was associated with a net biodiversity loss valued at approximately €80 per unit, with most of the environmental impacts concentrated in a region of Romania where the wood is sourced. This loss is entirely attributed to land use driven by wood cultivation activities. The estimated cost of biodiversity loss accounts for approximately 17% of the armchair's final retail price.

Comparison with alternative solutions

'Biodiversity Counts' delivers results comparable to those generated by other biodiversity valuation tools, such as IEF-Harvard (IEF, 2024) and True Price (Galgani et al., 2023) (see Figure 7). For the construction project, 'Biodiversity Counts' yields slightly higher but closely aligned results (4,778 versus 4,530–4,330 int$), while for the armchair, it reports significantly lower outcomes—approximately four times less (1,020 versus 4,530–4,330 int$). However, it is important to note that alternative tools assess biodiversity at the biome level, which limits their ability to account for nuanced biophysical and socio-economic contexts, leading to similar valuations across diverse case studies. For example, most of Europe is dominated by just three broad and heterogeneous biomes: temperate, mediterranean, and boreal forests (see Figure 8.) Furthermore, these tools focus solely on land occupation and transformation, neglecting other critical pressures on biodiversity, such as water availability and ecotoxicity. **While 'Biodiversity Counts' results align in magnitude with these tools, its innovative approach enables a more detailed and context-specific understanding of biodiversity impacts.**

Figure *7.* Monetised biodiversity impact by method for the housing construction project and furniture case studies.

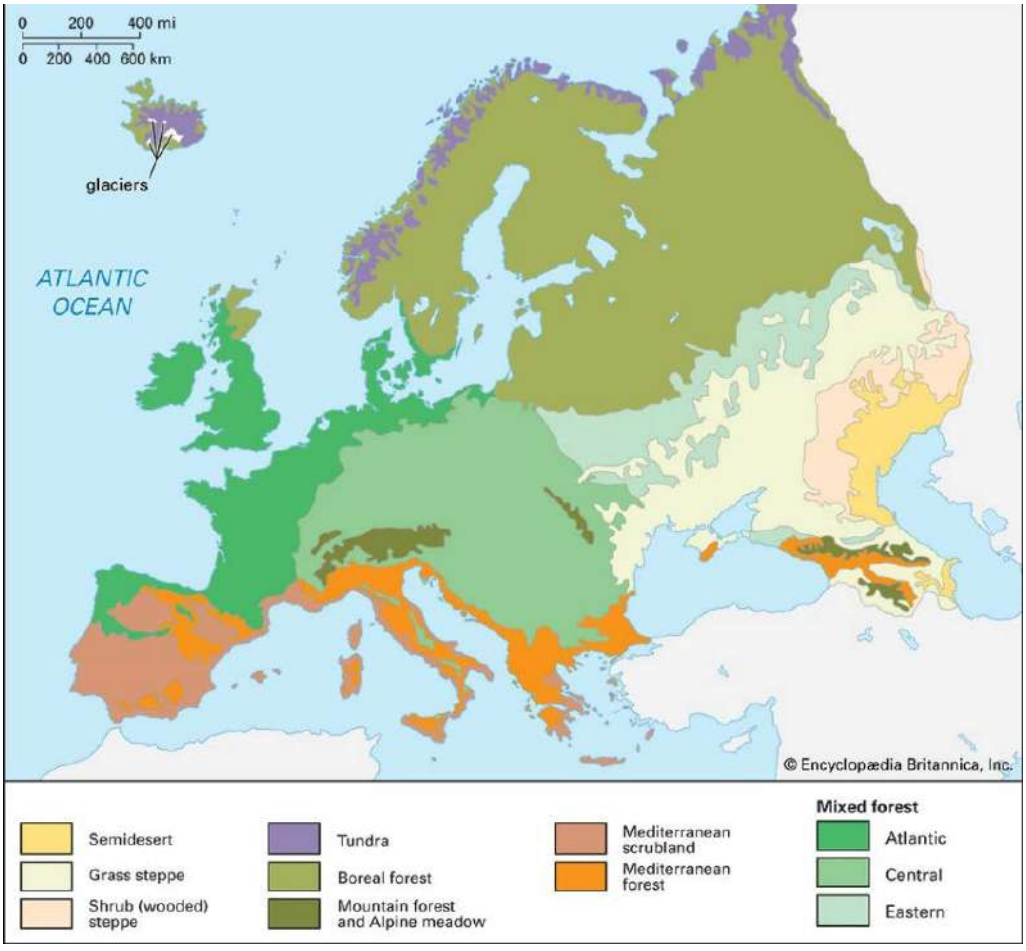


Figure *8.* European biomes. Source: https://www.britannica.com/place/Europe/Plant-life

Business Implications

The **obtained results carry substantial business implications** that can be categorized into six key broad opportunities: **risk management and compliance, financial performance and cost savings, reputation and brand value, business opportunities and innovation, ecosystem services and natural capital, policy influence and advocacy** (see Figure 9).

Figure 9. Key Business and Societal Benefits of Valuing Biodiversity (Based on van 't Hoff, V., Siebers, M., van Vliet, A., Broer, W., & de Groot, D. (2020). Make nature count: The need for valuing biodiversity. Foundation for Sustainable Development and ASN Bank.

The results reveal that the valuation of net biodiversity loss represents a significant yet often overlooked externality, accounting for 10–17% of the product's final retail price. While striking, these figures are in line with the internalisation of other impacts such as climate change, where incorporating the external costs of carbon emissions into product pricing leads to significant price increases across various sectors. For example, internalizing climate change impacts with a carbon price of $100 per ton CO_2 could result in price increases of 16–18% for petrol and diesel (World Bank, 2020), 50–110% for electricity generation depending on the energy source (European Environment Agency, 2019; International Energy Agency, 2020), 27% for beef (Poore & Nemecek, 2018), and 6.7–7.7% for air travel tickets (International Civil Aviation Organization, 2020).

These figures emphasize the profound influence biodiversity impact valuation could have on the decision-making processes of key stakeholders. For investors, integrating biodiversity costs into financial models would reshape capital allocation, incentivizing investments in projects and companies that either minimize their biodiversity footprint or actively work to mitigate their impacts. For businesses, incorporating biodiversity valuation into supply chains would encourage sustainable sourcing, drive innovation to reduce environmental harm, and redefine supplier relationships to prioritize ecological integrity. Consumers, too, could play a critical role: when confronted with products that transparently reflect biodiversity impacts in their pricing, they may favour sustainable alternatives, amplifying market demand for environmentally responsible products. This dynamic would not only enhance corporate accountability but also create a virtuous cycle, reinforcing the alignment between economic activity and the preservation of biodiversity.

Focusing on the value for businesses highlighted by the pilot cases, **the findings also underscore that a considerable portion of biodiversity impacts occur throughout the value chain, illustrating the critical importance of addressing indirect impacts alongside more immediate, direct effects.** Beyond the magnitude of these costs, their distribution and nature provide valuable insights for optimizing biodiversity impacts and associated costs. In both case studies, wood products emerged as the primary contributors to biodiversity loss, suggesting that prioritization of interventions in this area could yield significant benefits. For the housing project, optimizing wood types and sourcing locations while maintaining the core project requirements resulted in up to 80% reduction in costs, from approximately €500,000 to €100,000. In contrast, for armchair production, short-term modifications to wood type and sourcing were constrained by existing contractual obligations. However, the findings have prompted discussions with the supplier to improve data quality and explore the implementation of more sustainable logging practices.

06.Conclusion

Benefits of the solution

The intersection of organizations and environmental sustainability has become increasingly significant. Biodiversity, a vital component of our planet's health, is under threat from various industrial activities, posing significant risks not only to the environment but also to the long-term viability of organizations themselves. Recognizing this challenge, 'Biodiversity Counts' can be used to achieve benefits for multiple stakeholders. 'Biodiversity Counts' offers key advantages over existing tools by integrating a broader range of biodiversity pressures, leveraging high-resolution spatial data, incorporating dynamic economic valuation based on ecosystem services, and ensuring greater transparency and comparability in biodiversity impact assessments.

Business Benefits

From a risk management perspective, 'Biodiversity Counts' enables companies, investors and public administration to quantify and internalize the financial repercussions of their biodiversity impacts, thereby identifying potential threats to resource sustainability and operational stability. Such information can be used to formulate mitigation strategies that protect essential natural resources and secure long-term business operations. In terms of regulatory compliance, the solution provides insightful metrics and data that can be used for key frameworks such as CSRD ESRS E4, TNFD and possibly EU Taxonomy. Moreover, the solution plays a significant role in enhancing corporate reputation by demonstrating a proactive commitment to environmental sustainability.

Environmental Impact

The potential positive outcomes for biodiversity conservation through the utilization of this solution are profound. By equipping organizations with precise, monetized insights into their biodiversity impacts, the solution encourages a vision of biodiversity as a value. This therefore fosters the adoption of biodiversity and nature practices within organizations. Informed organizations are more likely to implement measures such as habitat restoration, sustainable resource management, and pollution reduction.

Policy Implications

For policymakers, this solution could serve as an invaluable resource in the development of informed and effective environmental policies and regulations. By providing detailed, monetized data on the impact of business activities on biodiversity, the solution offers a robust foundation for crafting targeted legislation designed to address specific ecological challenges. Policymakers can utilize this information to pinpoint industries or regions where biodiversity is most threatened and develop tailored policies to mitigate these risks.

Beyond regulation, fiscal and market-based incentives can play a crucial role in encouraging businesses to adopt biodiversity-friendly practices. Tax incentives, subsidies, and preferential treatment in public procurement for companies with strong biodiversity commitments can help drive change. Notable examples include England's Biodiversity Net Gain (BNG) policy, which mandates that developers ensure a net 10% increase in habitat restoration, creating a market for biodiversity credits that incentivizes investment in conservation. Similarly, Colombia's Biodiversity Bonds, launched at COP16, attract private sector investment into biodiversity projects, aligning financial returns with environmental benefits. These mechanisms demonstrate how financial incentives can enhance business engagement in biodiversity conservation while driving systemic change.

In conclusion, the integration of this solution into business operations and policymaking frameworks represents a significant stride towards sustainable development. For companies, it offers a practical solution for managing potential biodiversity risks, ensuring regulatory compliance, and enhancing corporate reputation. For the environment, it fosters the adoption of conservation practices that safeguard and enhance biodiversity. For policymakers, it provides the empirical foundation needed to craft informed, effective policies that harmonize economic and environmental goals. Through collaborative efforts and the widespread adoption of this solution, we can pave the way for a future where both companies and biodiversity thrive symbiotically.

Challenges and Limitations

The development of 'Biodiversity Counts' has revealed significant challenges related to the complexity of valuing biodiversity, computational performance, and data availability.

Technical Challenges

A significant challenge in biodiversity valuation lies in the lack of scientific consensus on methodologies, which complicates standardization across sectors. While ecosystem services provide a good spatial correlation for assessing biodiversity impacts, they often fail to capture the full ecological and socio-economic value of biodiversity (Millennium Ecosystem Assessment, 2005; Dasgupta, 2021). Geolocated life cycle inventories, spatial datasets, and coordinate-level computations present additional hurdles due to their computational intensity and scalability limitations (IPBES, 2019). Moreover, fragmented global databases, such as Global Biodiversity Information Facility (GBIF) and the International Union for Conservation of Nature (IUCN) Red List, often lack the granularity required for detailed geospatial analyses, hindering efforts to address regional biodiversity variations. Collaborative initiatives are needed to enhance data collection, improve computational tools, and refine valuation methodologies to ensure more accurate, scalable, and actionable biodiversity assessments.

Data Limitations

Progress is hindered by significant gaps in data availability and quality, particularly in the geographical precision of impact characterization factors and the limited volume of ecosystem services valuation data. For example, IW+ currently lacks characterization factors for critical impacts like climate change, and the geographical resolution for certain impacts remains coarse, limiting the accuracy and utility of assessments. Addressing these gaps requires improved data collection, harmonization, and integration across scales to support more precise and actionable biodiversity evaluations.

Future Improvements

Addressing these technical and data-related limitations is crucial for improving the accuracy, reliability, and scalability of 'Biodiversity Counts'. **Future iterations of the solution must incorporate refined methodologies, enhanced data integration, and improved computational efficiency to support broader adoption and greater impact.**

Call to Action

As demonstrated by pilot projects, 'Biodiversity Counts' empowers stakeholders to integrate biodiversity considerations into critical decision-making, such as supplier selection and investment strategies. Similar to how carbon pricing has driven companies to reduce emissions and invest in low-carbon technologies, 'Biodiversity Counts' enables organizations to prioritize practices that minimize biodiversity loss and identify high-impact areas in their supply chains. By monetizing biodiversity changes, 'Biodiversity Counts' allows companies to assign value to nature-positive solutions, such as ecosystem restoration, and emphasizes the economic benefits of these actions.

According to the European Commission (2022), “investment into nature restoration adds €8 to €38 in economic value for every €1 spent, thanks to ecosystem services that support food security, ecosystem and climate resilience and mitigation, and human health.” 'Biodiversity Counts' quantifies the value of such solutions, strengthening their business case and encouraging companies to invest in practices that drive both economic growth and biodiversity conservation.

Outlook

The concept of internalizing externalities is well-established and supported by extensive empirical research, dating back to the pioneering work of economist Arthur Pigou in welfare economics. Pigou introduced the idea that organizations should account for the social costs of their activities, laying the groundwork for modern environmental policies. Carbon pricing serves as a successful example of this principle in practice, demonstrating that, when effectively implemented, it can drive substantial reductions in greenhouse gas emissions and foster sustainable business practices.

Building on the experience with carbon pricing, the integration of biodiversity valuation into corporate financial accounting is emerging as the next crucial step in addressing environmental challenges. Biodiversity valuation provides a direct measure of ecosystem damage, offering a more accurate assessment of environmental impacts. This approach facilitates compliance with evolving regulatory frameworks such as the CSRD and the EU Taxonomy, while consolidating diverse environmental pressures into a single, actionable indicator—enabling clearer and more informed decision-making. Moreover, it aligns with increasing consumer and investor expectations for corporate responsibility, further embedding sustainability into core business strategies.

Biodiversity is not only a vital service provider for humans and other species but also plays a critical role in regulating the carbon cycle. The mix of flora and fauna significantly impacts nature's carbon storage capacity, making biodiversity preservation essential to successful decarbonization efforts. Decarbonizing ecosystems without considering biodiversity loss can have a detrimental rebound effect on the entire carbon cycle.

Therefore, the social cost of carbon should incorporate biodiversity valuation to reflect its true economic impact. Initiatives such as the Dutch certification of bio-based products in buildings for carbon credits should expand their scope to include biodiversity aspects, ensuring that circular raw material sourcing, such as sustainably managed timber, is appropriately valued over non-circular alternatives.

By incorporating biodiversity valuation into corporate financial accounting, organizations can progress towards a harmonized triple accounting system, integrating financial, environmental, and social metrics. Companies that adopt this approach gain a competitive advantage by simplifying compliance with regulations, reducing reporting errors, enhancing transparency, and improving investor confidence. A well-structured triple accounting framework facilitates better risk management, enables strategic resource allocation, and strengthens corporate reputation by demonstrating a commitment to sustainability and accountability. Additionally, by streamlining reporting processes and integrating data into a unified system, companies can achieve significant resource savings, reducing administrative burdens and operational costs associated with fragmented reporting systems. Moreover, companies that proactively measure and integrate biodiversity considerations into their operations also position themselves advantageously for future potential incentives, such as tax benefits or preferential treatment for nature-friendly products, as governments increasingly recognize the importance of biodiversity conservation in economic policies. This, in turn, fosters improved stakeholder relationships, access to sustainable finance opportunities, and a stronger position in an increasingly ESG-driven market.

Despite these benefits, the global biodiversity financing gap, estimated at $598 billion to $824 billion annually (Deutz et al., 2020), remains a significant challenge, with current spending between $124 billion and $143 billion per year, predominantly from public sector contributions of $67 billion to $78 billion. Bridging this gap requires a concerted effort to mobilize private sector investments and develop financial mechanisms that integrate biodiversity considerations into corporate decision-making processes.

A key step in closing the financing gap is the ability to quantify and monetize biodiversity impacts, making them visible and actionable within corporate accounting frameworks. **Tools such as 'Biodiversity Counts' offer a structured approach to incorporating environmental considerations into financial decision-making by translating biodiversity impacts into economic terms.** This allows businesses to align their strategies with regulatory requirements, optimize resource allocation, and mitigate biodiversity-related risks.

Biodiversity credits are emerging as a key mechanism to mobilize private sector funding for conservation efforts and address the financial shortfall. However, unlike the more mature carbon markets, biodiversity credits face challenges related to standardized metrics, robust monitoring, and regulatory frameworks. Solutions like 'Biodiversity Counts' can enhance the credibility and effectiveness of these markets by providing reliable valuation and measurement tools. This enables organizations to invest confidently in biodiversity initiatives, ensuring alignment with corporate sustainability goals while demonstrating tangible conservation outcomes.

Looking ahead, **biodiversity valuation has the potential to become a cornerstone of sustainable business practices, fostering a future where economic growth and environmental stewardship go hand in hand.** When paired with a similarly monetized indicator for human health impacts, organizations can integrate a comprehensive spectrum of environmental and social considerations into their financial accounting systems, driving a holistic approach to sustainability and responsible business practices.

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