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Nature in Impact Accounting for Business Steering

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About the VBA

The Value Balancing Alliance (VBA) is a coalition of around 30 multinational companies committed to driving sustainability by measuring and valuing corporate impacts on nature and society. Our world has been running through the most significant structural change in the last 250 years. We experience the environmental credit crunch: The paradigm of economic growth building on infinite resources is over. We enter the impact economy – requiring a new understanding of value creation[1]. VBA's mission as a not-for-profit alliance is to jointly create a globally applicable and comprehensive methodology together with the International Foundation for Valuing Impacts, Inc. (IFVI) for measuring sustainable value creation – impact accounting. Impact accounting has been successfully tested over the last fifteen years by leading companies across regions and industries. It gains more and more traction as a solution to translate ESG metrics into the language of business (monetization) and turning the sustainability reporting challenge into a force for value creation. The VBA is pioneering impact accounting in various collaborations, which contextualizes sustainability data and translates it into comparable monetary values, reflecting corporate impacts across the entire value chain.

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The document has been developed in collaboration with the Bio-Mo-D Project. As Nature in Impact Accounting is an evolving topic, comments and feedback for future updates are welcome. Please direct feedback to: methodology@value-balancing.com.

[1] UBS – The Rise of the Impact Economy, 2023

1. Purpose of the document

The purpose of this document is to build a clear and comprehensive understanding of how the natural environment is integrated into impact accounting, and how this can support more effective business decision-making. It does so by addressing the following three aspects:

1. Making the case for using impact accounting for nature in business steering to manage risks and resilience (in own operations, supply chains and product design) and to address regulations (i.e. CSRD and EUDR), related frameworks (i.e. TNFD and SBTN) and coherent climate-nature transition plans.

2. Defining the role of nature in impact accounting and clarifying related concepts and terminologies to enable users of the IFVI/VBA methodologies to establish a comprehensive impact accounting for nature addressing regulatory requirements and internal decision making.

3. Providing the methodological foundations for the impact driver *Resource Use* for assessing high-impact commodities and outlining two possible approaches: 1) using Input-Output Modelling and 2) using Life Cycle Assessment (LCA).

2. Using nature in impact accounting for business steering

Impact accounting focuses on the assessment and monetary valuation of positive and negative impacts of entities, allowing impacts to be factored into decision making alongside financial information. This helps businesses to integrate sustainability information into decision-making by translating non-financial information into monetary terms. Impact accounting enables businesses to develop a holistic understanding and management of impact drivers with relevance for climate and nature. This is critical for the design of coherent strategies, targets and transition plans. In the end, a transition to nature positive[2], as outlined in the Vision of the Convention Biological Diversity[3], is only possible, if impacts are assessed, managed and reduced. Impact accounting provides an important tool for corporates and financial institutions to enable such coherent business steering.

Impacts and dependencies on nature are of direct relevance for own operations and supply chains of many sectors with more than half of global Gross Domestic Product (GDP) being directly dependent on nature [4]. However, the significance of nature for a business model is often only realized, when ecosystems and their services are lost (e.g. physical risks related to lack of clean water, natural resources, pollination, etc.) or when impacts lead to legal and reputational challenges (transition risk). The extent and characteristics of these risks depend heavily on a company's business model and sector. The VBA Value-to-Business Framework[5] offers guidance on how impact accounting can be applied to assess the effects of nature-related risks and dependencies on corporate cash flows and enterprise value.

[2] Nature Positive Initiative: https://www.naturepositive.org/
[3] Convention on Biological Diversity: https://www.cbd.int/gbf/vision
[4] Herweijer et al. (2020) Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy. World Economic Forum.
[5] VBA (2025) Introduction to the Value-to-Business Framework.

Assessing impacts and dependencies on nature is increasingly regarded to be critical for risk management and business steering. In impact accounting the drivers contributing to the loss of nature are being assessed for their contribution to the loss in ecosystem service. Monetary valuation expresses the loss of benefits related to the decline in ecosystem services, not the loss of individual species. The IFVI/VBA methodology includes impact accounting of key drivers for biodiversity loss including land use and conversion, resource use, climate change and pollution (see overview in Figure 4).

Central banks and supervisors have identified the loss of nature as a systemic risk to the stability of the financial system[6] and financial institutions and investors are increasingly required to assess impacts and dependencies on nature, as shown by the guidance provided by the European Banking Authority[7]. However, such information is also in the self-interest of investors as identified in a global survey by the IFRS - International Sustainability Standards Board (ISSB)[8]. Consequently, reporting requirements, such as the EU Corporate Sustainability Reporting Directive (CSRD) and the EU regulation on deforestation-free products (EUDR), and voluntary frameworks, such as those developed by the Taskforce on Nature-related Financial Disclosure (TNFD), ask entities to assess and disclose impacts and dependencies on nature for guiding decision making.

Impact accounting can help entities in identifying and managing impacts on nature in supply chains and own operations. This can inform decision making in three main areas: first, sustainability strategies and risk management (e.g. related to product design, supply chains, or circularity), second, stakeholder engagement (e.g. with suppliers or investors), and third, compliance with reporting requirements (e.g. CSRD and EUDR).

Sustainability strategies and stakeholder engagement

Impact accounting can help identifying high-impact supply chains and business operations which can inform alternative business strategies that are more resilient and with less impact risks. Areas of high impact are generally associated with greater risks that need to be targeted in management, reporting and transition planning. For example, using resources that contribute to deforestation lead to biodiversity loss and degradation of ecosystems and their services, such as water and soil quality. This involves not only physical risks for the entity and its supply chain but comes also with considerable transition risks that can arise from negative impacts on stakeholders and related regulations.

Impact accounting can help assess alternative management options for mitigating and reducing impacts and associated risks across supply chains and own operations. Positive outcomes can include more resilient supply chains and business models that are better aligned with stakeholders. For example, a more sustainable sourcing of certified wood and efficient resource use in production processes can reduce impacts, while enhancing climate resilience in production processes. Creating such positive impacts can foster synergies across climate - nature strategies and support networks with suppliers and stakeholders.

Gaining a holistic understanding of impact drivers with relevance for nature in both physical and monetary terms can support more coherent and resource efficient sustainability

[6] NGFS (2022) Central banking and supervision in the biosphere: An agenda for action on biodiversity loss, financial risk and system stability. Final Report of the NGFS-INSPIRE Study Group on Biodiversity and Financial Stability.
[7] European Banking Authority (2025)
[8] ISSB (2025) Evidence of Investor Interest in BEES-related risks and opportunities. Staff Paper.

strategies on nature and climate. Such coherent sustainability strategies and transition plans can support the overall resilience of an entity.

Sustainability reporting for CSRD and TNFD assessments

In the context of CSRD reporting and TNFD assessments, impact accounting can be used in double materiality assessments (DMAs) for identifying key impact drivers in own operations and supply chains as demonstrated by various VBA use cases[9]. Areas of high impact can come with greater business risks and indicate areas that require attention for management, reporting and transition planning. The monetary valuation of CSRD datapoints can translate sustainability reporting into financial information that is compatible with established business steering tools. Thereby, impact accounting can feed into sustainability strategies and transition plans.

Coherent transition plans for climate and nature

As outlined above, using impact accounting for translating sustainability information into financial information can feed into business steering and transition planning. Impact accounting can help prioritize sustainability strategies and reveal synergies and trade-offs in sustainability targets and strategies, e.g. related to climate and nature, which can guide the development of coherent and efficient transition plans. For example, for some entities and supply chains, impacts on nature from land use may be of greater relevance than climate impacts from greenhouse gas (GHG) emissions. Adjusting strategies accordingly will ensure greater effectiveness of related sustainability strategies. Impact accounting can also be used in monitoring of targets for reducing impacts and serve as tool for implementing frameworks such as the Science-Based Target Network (SBTN). The holistic understanding and management of impact drivers with relevance for climate and nature is critical for the design of coherent strategies, targets and transition plans. In the end, a transition to nature Positive[10], as outlined in the Vision of the Convention Biological Diversity[11], is only possible, if impacts are assessed, managed and reduced.

EUDR reporting on deforestation-free products

In the context of the EU regulation on deforestation-free products (EUDR), IFVI/VBA impact accounting can help assess the relevance of high-impact commodities within own operations and supply chains. The presented methodology on resource use (see Section 5) focuses on impact accounting for commodities relevant for EUDR. These include wood products, soybeans, palm oil and natural rubber. While impact accounting allows assessing impacts across the value chain, the VBA piloting in 2024/25 focuses on resource use in the upstream supply chain. This can inform, for example, decision making on procurement and sourcing of resources, e.g. from certified, deforestation-free producers, and sourcing from regions with lower impacts. Thereby, the presented approach can be used as tool for translating EUDR reporting requirements into decision-relevant guidance and targets for sustainable sourcing strategies and production processes. If high-impact commodities are a material topic for the supply chain of an entity, then the presented methodology on

[9] VBA (2024) Impact Accounting applied in DMA under CSRD. Understanding the value chain & material impacts of ZF Group; VBA (2025) Advancing DMAs with Impact Data: How SAP enhanced objectivity in their DMA.
[10] Nature Positive Initiative: https://www.naturepositive.org/
[11] Convention on Biological Diversity: https://www.cbd.int/gbf/vision

impact accounting of resource use (see Section 5) can provide a tool for designing coherent management strategies, targets and transition plans for more sustainable, deforestation-free products.

3. Accounting for nature's role in the economy

Nature comprises the living and non-living fabric of our planet and underpins human wellbeing and the economy. Nature includes biodiversity, geology, hydrology, oceans, the atmosphere, climate and their interactions. Biodiversity represent the living part of nature and includes the variety of species, genes and ecosystems of the terrestrial, aquatic and marine environment[12]. Without nature there are no humans and no economy.

Recognizing this inseparable link of nature and the economy, central banks have identified the loss of nature and its biodiversity as a systemic risk to the economy and the financial system (NGFS 2022)[13]. A recent survey by the ISSB found that the majority of investors are aware of the need to integrate impacts and dependencies on nature into decision making and ask for more standardized approaches to reporting and valuation (ISSB 2025)[14]. Norway's Government Pension Fund, the largest sovereign wealth fund with USD 1,7 trillion in assets under management and holding 1.5% of globally listed companies, is integrating climate and nature into risk assessments by assessing its impacts and dependencies on nature[15].

The VBA uses the Value-to-Society perspective to address positive and negative impacts an entity has on nature and society, while the Value-to-Business perspective is used to address dependencies on nature and society, as well as resulting risks and opportunities (Figure 1).

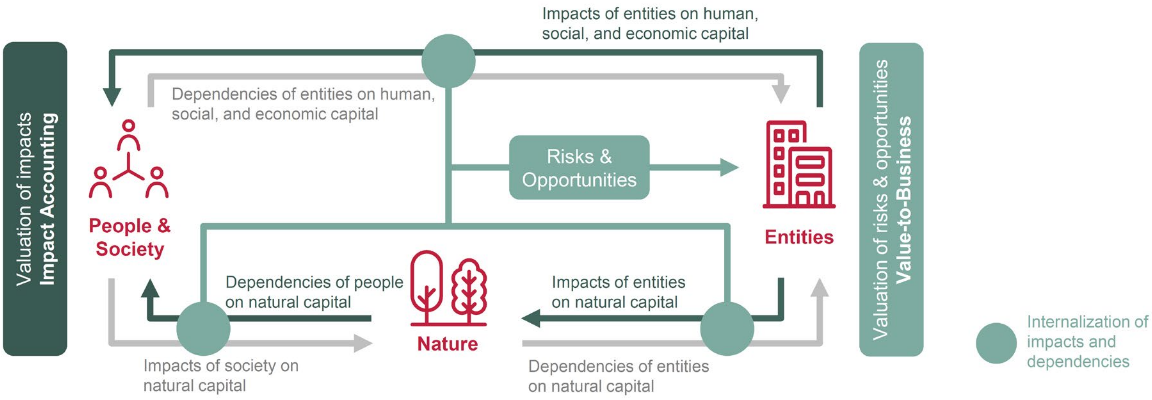
[12] According to the UN Convention on Biological Diversity (CBD) biological diversity is the "... variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems."

[13] NGFS (2022) Central banking and supervision in the biosphere: An agenda for action on biodiversity loss, financial risk and system stability. Final Report of the NGFS-INSPIRE Study Group on Biodiversity and Financial Stability.

[14] ISSB (2025) Evidence of Investor Interest in BEES-related risks and opportunities. Staff Paper.

[15] Norges Bank Investment Management (2024) Climate and nature disclosures 2024. Government Pension Fund Global.

Figure 1: Impacts and dependencies on nature in the context of Value-to-Society and Value-to-Business as guiding perspectives used by the VBA. Based on Capitals Coalition (2016): Natural Capital Protocol.



3.1 Impacts on nature (Value-to-Society)

While many economic sectors directly and indirectly depend on nature and make use of natural resources (e.g. clean water, wood, fibre and soils), there are many economic activities that impact nature. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) found that worldwide, biodiversity is in dramatic decline, with economic activities being main drivers.[16] According to IPBES, key impact drivers for this loss in nature include the use of land and sea, direct exploitation of natural resources and species, climate change, pollution and the spread of invasive alien species. These impact drivers degrade ecosystems and undermine the services that nature provides to society and the economy. Hence the loss of nature increases systemic risks to the economy, as shown by a recent assessment of the financial materiality of nature for the economy of the United Kingdom (UK)[17]:

> *"The findings demonstrate that biodiversity loss and environmental degradation create material risks for the UK economy and financial sector, in addition to their wider social and biodiversity impacts. These impacts are near and present. We find that the deterioration of our natural environment could slow economic growth and result in UK Gross Domestic Product (GDP) being 6% lower than it would have been otherwise by the 2030s under two scenarios […] These are greater than the impact on GDP experienced in the Global Financial Crisis, in which UK GDP fell by around 4% to 6% […] While these findings are preliminary, all the evidence points to them being conservative."*

The implications of these impacts on nature in terms of ecosystem services lost can be global (e.g. loss of carbon sequestration contributing to climate change) or local (e.g. decline in soil productivity and water quality) and contributes to exceeding planetary boundaries by putting the functioning and resilience of the biosphere (i.e. nature) at risk. Trespassing thresholds in the earth system can lead to irreversible changes with potentially long-term negative consequences for society and economy.[18] Mitigating and reversing such impacts on nature (e.g. through restoration activities) can help in recovering

[16] IPBES (2019) Global Assessment. URL: https://zenodo.org/records/3553579
[17] Green Finance Institute (2024) Assessing the Materiality of Nature-Related Financial Risks for the UK.
[18] Planetary Health Check (2024).

biodiversity and enhance the delivery of ecosystem services. Hence, strategies for mitigating impacts on nature and restoring degraded ecosystems and their services, for example, as part of climate and nature transition plans, can contribute to nature positive outcomes at local to global scale[19].

3.2 Dependencies on nature (Value-to-Business)

Nature with its biodiversity and ecosystems provide ecosystem services that are vital for sustaining the wellbeing of people and the economy. For example, ecosystems are critical for the provision of clean air and water and maintaining soil productivity. Pollination by insects sustains about 75% of global food production[20]. Ecosystems also provide biomass (e.g. in the form of wood) as basis for a wide range of materials and production processes.

A study by the World Economic Forum and PwC estimates that more than half of global GDP[21] and more than half of the market value of listed companies (about US$45 trillion) is dependent on ecosystem services provided by nature and hence subject to nature-related risks[22]. The European Central Bank (ECB) estimates that 72% of European businesses and 75% of corporate loans are highly dependent on at least one ecosystem service[23]. Therefore, conserving biodiversity for securing well-functioning ecosystems with their ecosystem services are critical for a sustainable and resilient economy and society (Figure 2).

However, not only the provision of goods and products as input into production processes is important. Forests, wetlands and oceans significantly contribute to carbon storage and climate change mitigation. Ecosystems can enhance resilience to extreme events and climate change, for example, by influencing local climate regulation (e.g. cooling effects and moderating rainfall), regulating water flows in rivers, and maintaining favourable conditions for agriculture, forestry and food production. This also contributes to favourable living conditions in urban areas.

Therefore, assessing the link of businesses with nature and integrating nature into business steering is critical for the resilient business models. For example, financial institutions increasingly assess nature-related risks within their portfolio such as Norges Bank, which recently assessed 96% of its Net Asset Value (NAV) for dependencies on nature.[24]

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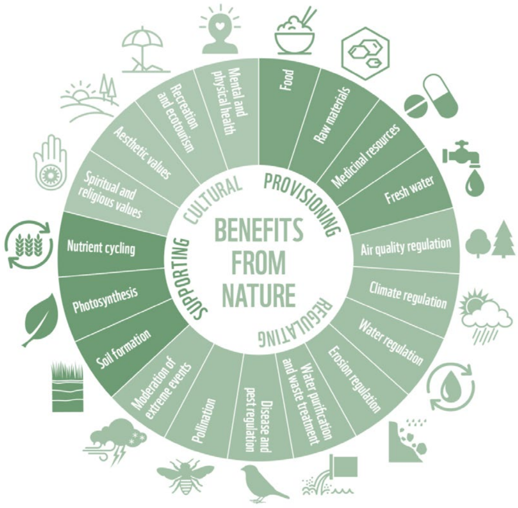
[19] Nature Positive Initiative. URL: https://www.naturepositive.org/
[20] IPBES (2019) Global Assessment. URL: https://www.ipbes.net/global-assessment
[21] Herweijer et al. 2020. Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy. World Economic Forum.
[22] Evison et al. 2023. Managing nature risks: From understanding to action. PwC.
[23] Boldrini et al. 2023. Living in a world of disappearing nature: physical risk and the implications for financial stability. European Central Bank.
[24] Norges Bank Investment Management (2024): Climate and nature disclosures 2024. Government Pension Fund Global.

Figure 2: Ecosystem Services providing multiple benefits to people and the economy. Source: WWF 2028[25]



3.3 Double Materiality

For understanding the relevance of nature for the economy with its sectors, entities, assets and operations, it is critical to take a double materiality perspective: the impacts that economic activities have on nature and the dependencies of these economic activities on ecosystem services (Figure 3).

Sustainability reporting under the CSRD and TNFD require a double materiality assessment that addresses both physical and transition risks[26]. However, irrespective of regulations, a double materiality assessment is also increasingly expected by the financial sector[27,28]. VBA has highlighted the use of impact accounting for a double materiality assessment and related decision making[29,30].

Physical risks occur, if the loss of nature is negatively impacting operations at own sites or the value chain, which can lead to costs due to damages to assets or disrupt production processes. This includes acute hazards resulting from extreme events such as floods, droughts, landslides or breakout of diseases and subsequent impacts on ecosystems and their services on which an entity depends. However, also slow, long-term ecosystem degradation, such as the decline in pollination, water availability, desertification or spread of diseases can have negative impacts on production processes (e.g. decline in cocoa production). Physical risks often result from an interplay of climate, short-term weather events and ecosystem degradation. Hence, there is the need to address climate and nature in combination.

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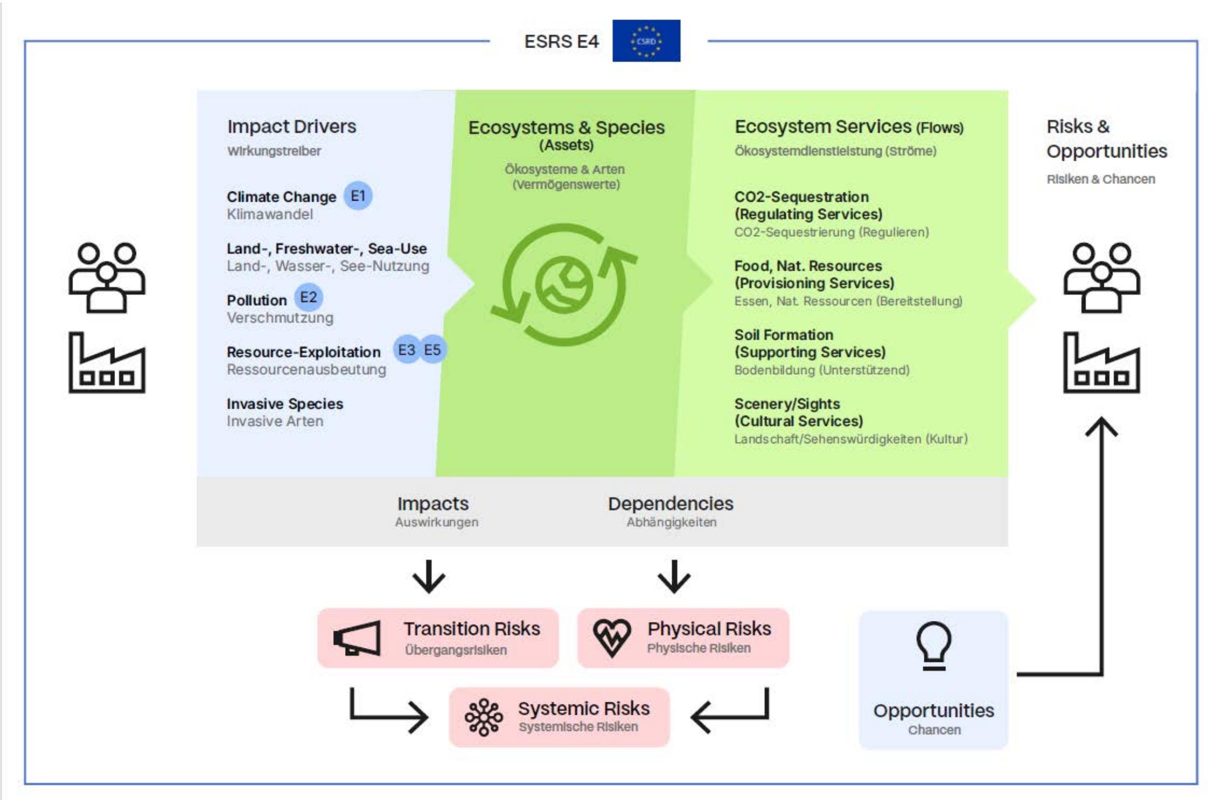
[25] WWF (2018) Living Planet Report.
[26] TNFD (2024) Recommendations of the Taskforce on Nature-related Financial Disclosure.
[27] ISSB (2025) Evidence of Investor Interest in BEES-related risks and opportunities. Staff Paper.
[28] Norges Bank Investment Management (2024) Climate and nature disclosures 2024. Government Pension Fund Global.
[29] VBA (2024) Impact Accounting applied in DMA under CSRD. Understanding the value chain & material impacts of ZF Group.
[30] VBA (2025) Advancing DMAs with Impact Data: How SAP enhanced objectivity in their DMA.

Such physical risks related to nature are typically assessed with a focus on the extent to which an entity and its supply chain depends on ecosystem services[31] and the consequences ecosystem degradation and loss of ecosystem services can have for an entity. Thereby, risks are not only related to external changes in ecosystems. Impacts by own operations can also cause physical risks for the entity itself by contributing to a decline in ecosystem services.

Transition risks involve legal and reputational consequences that can result from the impacts an entity or its value chain can have on nature and related societal impacts. Since many stakeholders depend on nature, transition risks linked to impacts can involve legal consequences from related regulations (e.g. EUDR), the loss of customers due to changes in public perceptions of an entity, or even the loss of an entities' social licence to operate.

The combined physical and transition risks related to nature pose systemic risks to the economy and the financial system (NGFS 2022[32]) and addressing such systemic risks requires holistic approaches (Figure 3). Impact accounting can help in assessing the relevance of the various impact drivers for nature loss and inform respective management strategies for addressing risks and opportunities.

Figure 3: Double materiality in the context of CSRD reporting (Source: Wildner et al. 2024[33]).



[31] For example, using the tool ENCORE: https://www.encorenature.org/en
[32] NGFS (2022) Central banking and supervision in the biosphere: An agenda for action on biodiversity loss, financial risk and system stability. Final Report of the NGFS-INSPIRE Study Group on Biodiversity & Financial Stability.
[33] Wildner, T.M., Lohmann, K.P., Förster, J., Kolb, M. (2024) Naturbezogene Abhängigkeiten und Chancen verstehen: Die Wesentlichkeitsanalyse als strategisches Instrument. Ein Praxisleitfaden der Umweltstiftung Michael Otto für den ESRS E4 der CSRD.

4. Using impact accounting for nature

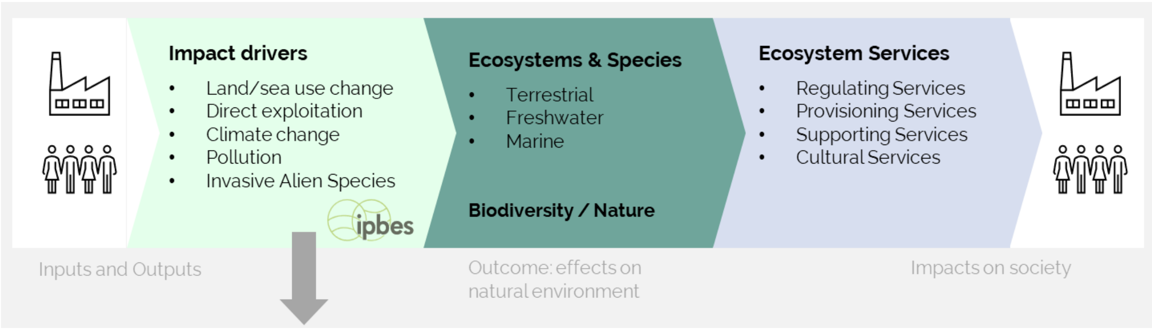
The global assessment of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) identified key impact drivers that have negative consequences for nature, including species, ecosystems and the delivery of ecosystem services[34]. These impact drivers include land and sea use change, direct exploitation of resources, climate change, pollution and invasive alien species, among others.

The IFVI/VBA impact accounting methodologies cover key drivers relevant for nature (Figure 4 and Figure 5). The IPBES impact drivers can be measured and monitored in physical terms (e.g. quantity of soybeans sourced and related area of land and water required for their production). However, physical indicators come in different units with little information on their socio-economic context. Hence monetary valuation as part of impact accounting can help to express impacts in a comparable unit, assess their relevance and serve as a tool for integrating impacts on nature into business steering (Section 1).

Following this accounting approach, the IFVI/VBA methodology addresses key drivers of nature loss, including land use change and conversion, direct exploitation including resource use and water consumption, climate change with impacts of GHG emissions, and pollution of air and water (summarized in the overview of Figure 4).

[34] IPBES (2019) Global Assessment. URL: https://www.ipbes.net/global-assessment

Figure 4: IPBES impact drivers for nature loss and their link to IFVI/VBA impact accounting.



Impact drivers for the loss of nature addressed by IFVI/VBA impact accounting:	
IPBES Impact Drivers & CSRD reporting topics	**IFVI/VBA Impact Accounting Methodologies**
Land use change **Sea use change**	**L1: Company scale impact accounting** for land use and conversion based on procurement data using Extended Environmental Input-Output (EEIO) modelling: ▪ VBA Methodology (2021) Extended Input-Output Modelling Version 0.1 **L2: Focus of impact accounting on specific activities in own operations or value chain involving land use and conversion** using primary data on impacted area, land use type & country together with the respective value factors of the IFVI interim methodology (see Section 5): ▪ IFVI (2024) Land Use and Conversion (Interim Methodology). Studies on impacts on the marine environment exist. However, impact accounting for sea use change is still an emerging topic.
Direct exploitation of resources: **Resource use related to terrestrial ecosystems** **Water use related to freshwater ecosystems**	**R1: Impact accounting focusing on high-impact commodities in terrestrial ecosystems,** using primary data on the quantity (in kilogram) of resources used & country of origin together with Life Cycle Assessment (LCA) and IFVI value factors (see Section 5). Resources can also be assessed using L1. Hence double counting can occur if both L1 and R1 are used in impact statements. ▪ IFVI (2024) Land Use and Conversion (Interim Methodology) **R2: Impact accounting related to water consumption** and related impacts on the provision of ecosystem services: ▪ IFVI ()2024) Water Consumption Topic Methodology (Exposure Draft)
Climate change	**Impacts of greenhouse gas emissions (GHG):** ▪ IFVI (2024) GHG Emissions Topic Methodology
Pollution	**Impacts related to air and water pollution:** ▪ IFVI (2024) Air Pollution (Interim Methodology) ▪ IFVI (2024) Water Pollution (Interim Methodology) **Impacts of waste & circularity** ▪ IFVI (2024) Waste (Interim methodology) ▪ Circularity is under development
Invasive Alien Species	Impact accounting for invasive alien species is still an emerging topic. Possible impact accounting pathways are under exploration.

The impact driver *resource use* (direct exploitation) related to the use of terrestrial ecosystems is addressed in Section 5. It focuses on high-impact commodities, which are increasingly subject to regulation, such as the EUDR. For the purpose of the VBA piloting, the resources wood, soybeans, palm oil and natural rubber have been included. The approach is based on Life Cycle Assessments (LCA) for determining how resource use is driving land use and conversion. The valuation is based on value factors for land use and conversion derived from IFVI Land Use and Conversion (Interim Methodology).

Impact accounting of the impact driver Invasive Alien Species is still an emerging topic. The VBA has conducted initial research on valuing impacts from invasive alien species based on the IPBES Assessment on Invasive Alien Species (IAS) and other scientific assessments. As part of the IPBES assessment, cost estimates for damage costs and management costs related to invasive alien species have been compiled[35]. Approaches have been explored for linking cost estimates related to IAS with risk estimates on the spread of invasive alien species due to transportation. However, further research is required to integrate the topic into the impact accounting methodology.

[35] For a comprehensive overview of societal costs related to invasive alien species see InvaCost: https://invacost.fr/en/accueil/.

5. Resource use in IFVI/VBA impact accounting

5.1 Resource use and its link to land use and conversion

For assessing impacts of resource use through land use and conversion, it is critical to understand key differences in their characteristics before informing decision making. Land use is a continuous form of ecosystem management (e.g. forestry) over a certain period (multiple years) with a focus on maintaining similar ecological conditions (e.g. productivity). It is often linked to the maintenance and continuous supply of ecosystem services, such as the production of resources like wood derived from forestry and commodities from agricultural production (e.g. soybeans). It can also be related to the use of land for buildings and infrastructure (e.g. industrial areas, roads, etc.).

In contrast, land conversion (e.g. deforestation) is a more abrupt change of an ecosystem and its conditions over a short period. Such changes can relate to direct resource use (e.g. wood extraction leading to deforestation) or be the result of constructions (e.g. a paved road). Conversion can lead to large changes in ecosystems and related ecosystem services within a short period of time (e.g. increased carbon emissions from deforestation). Hence ecosystem conversion is often characterised by higher impact values than land use. See the glossary (Appendix A) for related definitions.

Restoration can revert impacts from land use and conversions by re-establishing ecosystems and related ecosystem services (e.g. forest restoration for enhancing carbon storage). If successful, ecosystems and their ecosystem services can be restored over time with multiple benefits. However, while conversions involving the degradation or loss of ecosystems (e.g. deforestation) can take place within a short time, restoration of ecosystems often takes decades to centuries.

Different approaches can be used for impact accounting of resource use, land use and conversion (see Figure 4 and Figure 5). Each of the methodologies have their respective advantages for informing decision making and business steering as outlined in the following section and in Box 1.

5.2 Resource use as lens of land use and conversion pathway

Including *resource use* as indicator into impact accounting has the purpose of providing an option for addressing and managing high impact commodities in business steering. This targets in particular commodities contributing to deforestation as defined by the EU regulation on deforestation-free products (EUDR) and high-impact commodities defined by SBTN[36]. It also serves the purpose of accounting for all key impact driver of biodiversity loss as identified by IPBES (2019) and which are required to be addressed in materiality assessments under CSRD reporting. Thereby, the role of high-impact commodities within own operations or supply chains can be assessed in a more strategic approach (e.g. as part of materiality assessments). This also allows to inform sustainability strategies (e.g. on sourcing high-impact commodities) and related transition plans.

The topic of *resource use* is considered within the impact pathway on land use and conversion under "production of raw materials" in the IFVI interim methodology (see Figure

[36] SBTN's High Impact Commodity List (HICL). URL: https://sciencebasedtargetsnetwork.org/wp-content/uploads/2024/07/High-Impact-Commodity-List-v1-1.xlsx

5). Current VBA piloting includes the high-impact commodities wood products, soybeans, palm oil and natural rubber. These commodities are targeted by EU regulation on deforestation-free products (EUDR) due to deforestation risks related to their use (see Section 1). Corporates producing or sourcing these commodities have to address them within their EUDR reporting. Hence, information on quantities of these commodities sourced or produced (e.g. mass in tonnes or kilogram) can be used as input for applying the methodology (Figure 5) and inform decision making, for example, on more sustainable sourcing options and production processes (see Section 1).

As the production of high-impact commodities often requires the use of land and can contribute to the conversion of ecosystems (e.g. deforestation), the impact driver *resource use* is connected to the impact pathway of land use and conversion (corresponding to Input and Output in Figure 5). *Resource use* is impacting biomes and their ecosystems and is assessed by the area (in hectare) of ecosystem type used or converted for producing a particular resource (mass in kilogram). For more specific information on the conversion of resources into required land use or conversion see Section 5.3 and 5.4 and for more detailed definitions of biomes, ecosystems, land use and conversion see Section 5.5.

The changes in ecosystem services resulting from resource use and the associated land use or conversion required for its resource production are then monetized by applying the respective value factor from the IFVI interim methodology, which reflect the loss of ecosystem services. The IFVI value factors provide average estimates for valuing the impacts of land use and conversion, differentiated by biome and country level. The value factors have been estimated based on the IFVI (2024) Interim Methodology on Land Use and Conversion and using the Ecosystem Service Valuation Database (ESVD)[37]. Impacts on nature lead to changes in ecosystems and an increase or decrease of the delivery of ecosystem services (corresponding to Outcomes and Impacts in Figure 5). This change in the provision of ecosystem services can be valued in monetary terms.[38] It is important to note that not the impact on the life of species is being valued, but the change in the provision of ecosystem services and related benefits for human wellbeing is estimated in monetary terms. For example, the social cost of carbon can be used for valuing the contribution of one hectare of forest to sequester carbon dioxide from the atmosphere.

The link between ecosystems, the delivery of ecosystem services and their monetary values have been assessed in numerous scientific studies across the globe, which are compiled in the ESVD database. Findings of these valuation studies can be used to extrapolated values of ecosystem services across larger regions, which is called benefit transfer. In short, benefit transfer is used for estimating the monetary value of ecosystem services for a given location using values from already existing valuation studies that addressed a similar ecosystems and socio-economic context. Monetary values of ecosystem services are determined, among other, by the following criteria[39]: i) the type of benefits from ecosystem services being included and assessed; ii) the location, extent and condition of ecosystems and their characteristic biophysical processes; iii) the demand for and appreciation of ecosystem services by people and society within the locally specific socio-economic and cultural context; iv) the method used for valuing ecosystem services. Ideally, when using benefit transfer, the value of the original study needs to be adjusted for

[37] Ecosystem Service Valuation Database (ESVD): https://www.esvd.net/
[38] TEEB (2010), The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations. Edited by Pushpam Kumar. Earthscan: London and Washington.
[39] Förster J, Schmidt S, Bartkowski B, Lienhoop N, Albert C, Wittmer H (2019) Incorporating environmental costs of ecosystem service loss in political decision making: A synthesis of monetary values for Germany. PLoS ONE 14(2): e0211419. URL: https://doi.org/10.1371/journal.pone.0211419

any major differences in such aspects. This includes, for example, differences in ecosystem extent and conditions and related supply of ecosystem services (e.g. differences in carbon sequestration, water supply, nutrient cycling, water purification, primary productivity); differences in preferences between people living in rural and urban populations or between countries; differences in methodological approaches such as damage cost approach, replacement cost approach or willingness-to-pay approaches.

As described above, the presented approach to integrate *resource use* in impact accounting is building on general estimates of ecosystem service values, which has limitations in particular for taking locally specific aspects into account. Nevertheless, the approach allows to focus on specific high-impact commodities, production processes, countries and regions within own operations and across the value chain. This can provide a more granular lens on impacts and related risks linked to specific resources, compared to relying solely on land use and conversion estimates based on Extended Environmental Input-Output (EEIO) modelling[40]. The added level of detail can support reporting (e.g. under CSRD, TNFD and EUDR), inform management options, such as sourcing strategy adjustments, and guide the development and monitoring of transition plans (Section 1). The current VBA piloting includes resources use of wood, soybeans, palm oil and natural rubber (Section 5.3. and 5.4).

The same methodology can also be used if **primary data on land use and conversion** is available (L2 at lower right in Figure 5). This can be the case for entities that directly manage land or have close relations with the respective suppliers of commodities and thereby have access to primary data on locations and area of land (in hectare), where commodities are being produced (e.g. producers of agricultural and forestry products or companies with focus on food and wood processing).

In contrast to the LCA-based impact assessment with focus on high-impact resources (R1 and L2 in Figure 4 and Figure 5), land use impacts can also be assessed using EEIO modelling (L1 in Figure 4 and Figure 5). An EEIO-approach allows company-scale assessments of land use impacts based on expenditure data (procurement) for own operations and value chains. This approach is in particular useful for entities with highly diverse and complex supply chains and a diverse range of materials and products. It can help identifying processes and materials with high impacts on land use, which can be in particular relevant for materiality assessments. This EEIO-approach to impact accounting for land use is already established and documented as part of the VBA Methodology (2021) Extended Input-Output Modelling (Version 0.1)[41].

EEIO impact accounting (L1) has the advantage that procurement data is often readily available within companies and it provides a comprehensive overview of impacts across complex global supply chains for the entire company. However, the link between economic data from procurement and physical data of resource use and its origin is modelled based on global assumptions. This can help to identify areas of high impacts (e.g. as part of materiality assessment). The above outlined LCA-approach for impact accounting of resource use allows to focus assessments on specific high-impact commodities to inform, for example, supply chain management, sourcing strategies, product design and to set

[40] VBA (2021) Methodology Impact Statement. Extended Input-Output Modelling (Version 0.1). Value Balancing Alliance e.V.

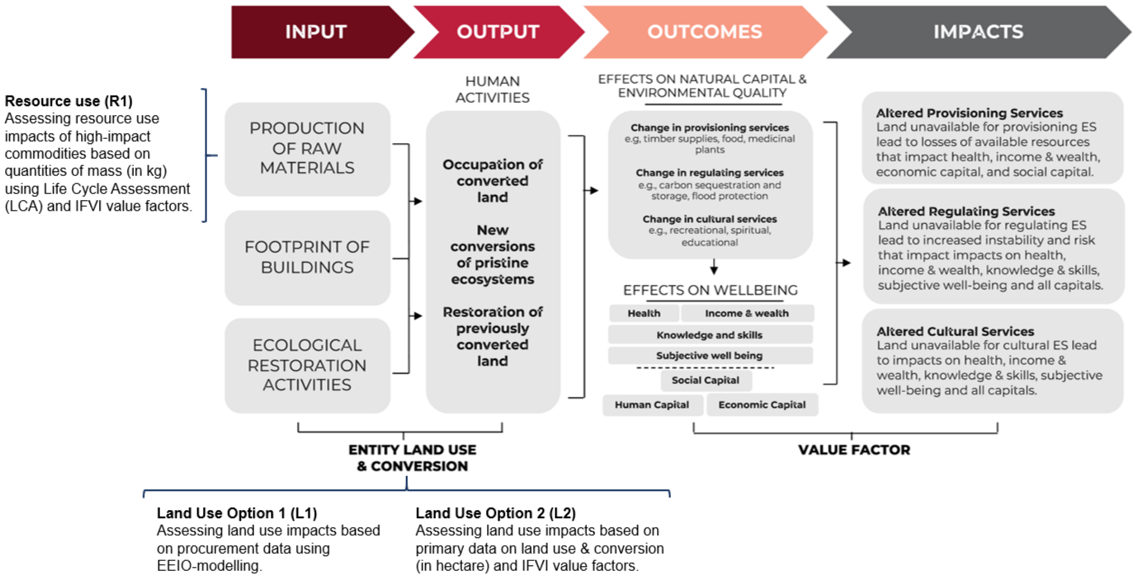
[41] VBA (2021) Methodology Impact Statement. Extended Input-Output Modelling (Version 0.1). Value Balancing Alliance e.V.

targets for transition plans (e.g. switching to deforestation-free supply chains could reduce impacts).

It is important to note that land use and conversion impacts and resource use impacts offer two distinct lenses on how ecosystem services are affected. As such, they should not be combined in a single impact statement. To avoid double counting, only one of these perspectives should be included.

Box 1 provides a summary of methods to estimate land use and resource use impacts, required data inputs, advantages and challenges.

Figure 5: Impact pathway of the IFVI (2024) interim methodology on land use and conversion with indication of options to quantify the required impact driver data. (Source of impact pathway: IFVI, 2024[42])



The conversion factors used for establishing the respective value factors of resource use are based on the most recent scientific LCA approaches as well as widely accepted data sources such as the United Nations Food and Agriculture Organisation (FAO). However, as with any LCA analysis such conversion factors involve assumptions and generalizations. Hence, changes in these underlying assumptions have influence on the conversion factors, the value factors and respective results of impact valuations. Hence it is important to be aware of the underlying assumptions when interpreting and using impact valuation. The following sections provide more detail on the underlying data of the respective value factors on resource use.

[42] IFVI (2024) Interim Methodology on Land Use and Conversion.

Box 1: Methods for assessing impacts of land use and resource use with data requirements, advantages and challenges.

One established **approach to quantify impact drivers for land use and conversion impacts** is based on procurement data combined with **Extended Environmental Input-Output (EEIO)-Modelling** (L1, lower left, Figure 5). This method is particularly relevant for entities with highly diverse and complex supply chains involving a wide range of materials and products. It supports the identification of purchased materials with high land use impacts, especially within upstream supply chains (e.g. as part of DMAs).

For some companies and industries, the IFVI interim methodology for land use and conversion can be used with **primary data** on land use and conversion (L2, lower right, Figure 5). This can be the case for entities that directly manage land or have close relations with the respective suppliers of commodities (e.g. area of land use by producers of agricultural and forestry products, area of constructions and existing buildings, area of ecosystem restoration).

Also the presented approach for impact accounting of **resource use** requires primary data, however more companies are likely to have primary data on purchased high-impact commodities then on land use or conversion. The methodology follows a Life Cycle Assessment (LCA)-based logic and can support decision making on specific areas of high impact, for example, in the management of supply chains.

Impacts of **resources use (R1)** and in particular high-impact commodities can be assessed using a **Life Cycle Assessment (LCA)-approach.** It is connected to the IFVI impact pathway under the topic of "production of raw materials" (R1, upper left, Figure 5). It builds on the IFVI land use and conversion interim methodology and requires information on quantities of mass (in kg) of commodities sourced or used. It is especially helpful for impact accounting and management of supply chains and production processes involving high-impact commodities. Currently, resources use of wood, soybeans, palm oil and natural rubber are included.

Method	Data requirements	Advantage	Challenge
L1: Company scale impact accounting for land use and conversion based on EEIO modelling. ▪ VBA Methodology (2021) Extended Input-Output Modelling Version 0.1 ▪ IFVI value factors of the IFVI (2024) Land Use and Conversion (Interim Methodology)	Procurement data	Efficient in assessing complex global supply chains and identifying areas of impact (e.g. as part of DMAs);	Low granularity due to high level of generalization; decision making on supply chain management likely limited to hotspot analysis;
L2: Focus of impact accounting on specific activities in own operations or value chain involving land use and conversion ▪ IFVI value factors of the IFVI (2024) Land Use and Conversion (Interim Methodology)	Primary data on land use and conversion in hectare, affected biome and country	High granularity due to direct use of land use data (in hectare); In particular suitable for businesses with direct land use (e.g. agriculture or forestry);	Primary data on direct land use often not available, if land use is not related to main business model; Difficult to use for assessing complex global supply chains that involve multiple types of resources driving land use impacts;
R1: Impact accounting focusing on high-impact commodities in terrestrial ecosystems (Section 5) ▪ IFVI value factors of the IFVI (2024) Land Use and Conversion (Interim Methodology) Conversion factors for: ▪ Wood products ▪ Soybeans ▪ Palm oil ▪ Natural rubber	Primary data on resource use in quantity of mass in kilogram, affected biome and country of origin	High granularity for impact accounting of high-impact commodities and to inform supply chain management;	Primary data on resources often not available for more complex products; Difficult to use for assessing complex global supply chains that involve multiple types of resources;

5.3 Impact accounting of the resource wood

The following section outlines the methodological approach for the monetary valuation of the impact of wood products, using a LCA-based approach for assessing resource use (R1) (see also Section 5.2, Figure 4 and Figure 5). The results of this approach reveal impacts of different wood products on nature and can be used for informing decision making, for example, on wood sourcing strategies (e.g. using certified wood sources) and product designs.

This impact accounting approach is assessing the link between the mass of wood sourced within supply chains to the impacts the harvesting of this wood has on forest ecosystems. Impacts are value in monetary terms based on the changes this impact has on the supply of ecosystem services (see Section 5.2.). Thereby, impacts from harvesting of wood are distinguished between impacts from the continuous use of forests in the form of forest management (i.e. forest regrowth after harvesting) and the conversion of forests due to deforestation.

In a first step, quantities of the mass of industrial roundwood and wood products (processed wood material, paper/carton, wood fuel) is converted into raw timber (with bark), that originally had to be harvested in the forest, using standard conversion factors provided by the FAO of the United Nations (Step 1 and 2 in Figure 6; Appendix Table 1). The raw timber equivalents are then converted into the forest area required for growing the respective timber, using estimates for the average yearly growth (annual increment) of forests. Average values for the Net Annual Increment (NAI) and Mean Annual Increment (MAI) (in m^3/ha/a) of forests are derived from LCA of wood products and timber trade including studies by Beck-O`Brien et al. (2022) and O'Brien and Bringezu (2018). NAI and MAI are available for different forest types with regional and global averages (Step 3 in Figure 6; Appendix Table 2). In this step, the forest area required to grow the timber for the respective wood product is estimated. Based on this quantification of the land use footprint (in hectare), the impact of forest use on the provision of ecosystem services is assessed and valued in monetary terms (in USD) using the value factors of the IFVI interim methodology (Step 4 in Figure 6; Appendix Table 4).

The IFVI value factors are modelled based on data of the Ecosystem Service Valuation Database (ESVD), which provides monetary values for ecosystem services of different forest biomes (see Section 5.1). The management and harvesting of forests cause changes in the provision of ecosystem services. Impacts of forest management can be valued by comparing the ecosystem services provided by managed forests with those of natural (pristine) forest ecosystems. For example, the impact from sustainable forest management is smaller than for deforestation, since under sustainable forest management a more natural flow of ecosystem services is being maintained. In contrast, the impact of deforestation is rather large as it leads to a long-term reduction or loss of forest ecosystem services.

The type of forest product covered by this methodology follow the FAO forest product classification (FAO 2022b) and are aggregated into a reduced number of product types to limit complexity. The forest product types include:

- *Industrial roundwood* in kilogram (kg) including raw wood material in the form of roundwood and sawn wood without any further processing.

- *Wood material* in kilogram (kg) that has been worked or processed including forest products that have undergone further processing such as roundwood treated with preservatives, wood-based panels, wood veneer, furniture, etc.
- *Paper / carton* in kilogram (kg) including paper, paperboard, carton, packaging material, etc.
- *Wood fuel* in kilogram (kg) including pellets, wood chips, etc., which are used as fuel and energy source.
- *Other* types of wood products in kilogram (kg).

Figure 6: Methodological approach and conversion factors for impact valuation of resource use for the high-impact commodity of wood and related products (sources provided in Appendix B).

Conversion of unit wood product (in metric t) into area of forest land (ha) used to grow the respective volume of timber within one year (m³/ha/a)					**Impact of forest use (land use) in terms of change in ecosystem services** (USD/ha)
Wood Product (in metric t)	**1. Conversion of wood product (metric t) into volume raw timber equivalent (m³) (without bark)**	**2. Conversion of volume raw timber equivalent (m³) into raw timber with bark**	**3. Conversion of volume raw timber equivalent (m³) into area (ha) of land needed to grow the timber (m³/ha/a)**	**4. Monetary valuation of forest land use (ha) in terms of change in ecosystem services** (IFVI Value Factor in USD/ha)	**Impact of wood product in terms of ecosystem service change** (USD/metric t)
Industrial roundwood (general) Wood material (general) Paper / Carton Wood fuel Other	Conversion factors based on O'Brien and Bringezu, 2018 App. A Table 1 Industrial roundwood = 1.33 (FAO 2012) Wood material (general) = 1.54 (FAO 2012) Paper / Carton = 3.45 (O'Brien and Bringezu 2018) Wood fuel = 1.38 (FAO 2012) Other = 1.53 (O'Brien and Bringezu 2018)	For raw timber with bark, 12% of volume is added to the raw timber equivalent without bark. Conversion factor = 1.12 (FAO 2020)	Growth of timber is estimated in m³/ha/a using values for Net Annual Increment (NAI) and Mean Annual Increment (MAI): NAI global average forests = 2.5 m³/ha/a MAI global average production forest = 9.3 m³/ha/a (Beck-O`Brien et al. 2022) NAI Europe = 5.9 m³/ha/a (O'Brien and Bringezu, 2018) Own assumption: Wood from certified sources is likely to originate from faster growing plantations with higher NAI and MAI (in particular for paper production). Own values: Certified wood (global average) MAI = 5.9 m³/ha/a; Certified wood for Paper/Carton MAI = 9.3 m³/ha/a; Non-certified wood (global average) NAI = 2.5 m³/ha/a;	Value of ecosystem services lost in comparison to pristine state (in USD per hectare) Based on IFVI Global Impact Values for Land Use: Forestry (IFVI Interim Methodology 2024)	Impact of wood products (for certified and non-certified sources) valued in USD per metric t: Industrial roundwood (general) Wood material (general) Paper / Carton Wood fuel Other

5.4 Impact accounting of resources soybeans, palm oil, natural rubber

The following section outlines the methodological approach for the monetary valuation of the high-impact commodities soybeans, palm oil and natural rubber, using an LCA-based approach for assessing resource use (R1) (see also Section 5.2, Figure 4 and Figure 5). These commodities have been selected as they can be linked to significant impacts on ecosystems and are therefore addressed under the EUDR and SBTN. The results of this approach reveal impacts of commodities on nature and can be used for informing decision making, for example, on sourcing strategies (e.g. by demonstrating benefits by using commodities from deforestation-free sources).

In a first step, global averages for the area required per year to produce one kilogram of the respective commodity have been compiled based on scientific literature and online resources (Step 1, Figure 7). In Step 2 this information is being converted into hectare values. In a next step, the area required is multiplied by the respective IFVI value factor[43]. For soybeans, the IFVI value factor on land use for conventional oilseed production has been

[43] IFVI (2024) Interim Methodology on Land Use and Conversion.

used. For palm oil and natural rubber, the IFVI value factor for forest land use has been applied, as their production is similar to forestry-like plantations. However, this is a very coarse estimate. In particular palm oil plantation can have impacts on biodiversity and ecosystem services that are significantly higher than for average forest plantations. A refined value factor would be required that better accounts for the impacts of palm oil plantations.

Figure 7: Methodological approach and conversion factors for impact valuation of resource use for the high-impact commodities soybeans, palm oil, natural rubber (sources provided in Appendix B).

Conversion of resource (kg) into area (ha) of land required for growing the resource per year (a)			**Impact of land use in terms of change in ecosystem services** (USD/ha)	
Resource (in kg)	**1. Area of land (in m²) needed per year for producing 1 kg of resource [soybean, palm oil, natural rubber]**	**2. Area of land (in ha) needed per year for producing 1 kg of resource [soybean, palm oil, natural rubber]**	**3. Monetary valuation of land use (ha) in terms of change in ecosystem services** (IFVI Value Factor in USD/ha)	**Impact of resource production in terms of ecosystem service change** (USD/kg)
Soybean	Global average = 3.85 m² * a / kg	Global average = 0.000385 ha * a / kg	1) IFVI Land Use values: Oilseeds (conventional) 2) IFVI Land Conversion values for high risk deforestation: oilseeds	Impact Soybean production (USD/kg)
Palm oil	Global average = 3.03 m² * a / kg	Global average = 0.000303 ha * a / kg	1) IFVI Land Use values: forestry (plantation) 2) IFVI Land Conversion values high risk deforestation: forestry	Impact palm oil production (USD/kg)
Natural rubber	Global average = 5.00 m² * a / kg	Global average = 0.0005 ha * a / kg	1) IFVI Land Use values: forestry (plantation) 2) IFVI Land Conversion values high risk deforestation: forestry	Impact natural rubber production (USD/kg)

To account for deforestation, IFVI value factors for forest conversion have been applied. If the percent of commodity originating from high-risk deforestation areas is known, the respective impact from deforestation can be estimated. Thereby, the respective quantity of the commodity from high-risk deforestation areas is converted into the area footprint (Step 1 and 2 in Figure 7). This area estimate can be assumed to have contributed to deforestation. Using the IFVI value factors for forest conversion allows to value the impact from deforestation.

6. Future development

Future developments in impact accounting for nature may explore ways to enhance its practical relevance for meeting regulatory requirements and supporting corporate decision-making. This could include the development of illustrative use cases to demonstrate how nature-related impact accounting can inform business steering and the design of transition plans.

To improve the integration of key impact drivers relevant to nature into impact accounting, potential areas for future work include:

- Refining value factors to better address regional and local differences in ecosystem service values due to differences in the characteristics of ecosystems, land use types and socio-economic conditions.
- Improving alignment of assumptions between EEIO-modelling and LCA-based approaches to increase consistency and support the use of hybrid methods to address data gaps.
- Expanding methodologies to cover additional impact drivers highlighted by IPBES, including the valuation of impacts from invasive alien species and marine or sea use.
- Considering the development of context-specific thresholds—at the country, local, or sector level—to improve the accuracy of nature-related impact estimates and enable performance comparisons between entities.

7. Appendix A: Glossary

Biodiversity: Biodiversity represents the living part of nature and includes the variety of species, genes and ecosystems of the terrestrial, aquatic and marine environment[44]. Species and ecosystems provide benefits to human wellbeing and the economy in form of ecosystem services.

Biomes: The interaction of living organisms (i.e. species) with their non-living environment such as the atmosphere, climate, soils and water lead to the formation of characteristic biomes. Among other factors, climate conditions determine the distributions of biomes around the globe (e.g. tropical forests in warmer climates and temperate forests in colder climates). Each biome consists of different ecosystems (e.g. the tropical forest biome includes forests, rivers, lakes, mountain ecosystems, etc.). Each of these ecosystems can provide different ecosystem services depending on factors like climate conditions, water availability and soil characteristics (e.g. the growth of a forest measured in net primary productivity differs between a pine forest and a tropical forest).

Ecosystems: Ecosystems are part of biodiversity and are the result of the interaction of species with their living and non-living environment. Ecosystems include forests, lakes, rivers, grasslands, coral reefs, etc. Within ecosystems, species are interconnected in complex networks. For example, many plants depend on insects, birds and mammals for pollination and seed dispersal. Species are also adapted to specific climate conditions, specialized on nutrient and water availability, and can act in symbiosis.

Ecosystem services: Ecosystems provide benefits to people and the economy in the form of ecosystem services. These include provisioning services such as food and water; regulating services such as flood and disease control; and cultural services such as recreation, ethical and spiritual services, educational services and sense of place. The provision of ecosystem services can be altered by impact drivers for biodiversity loss.

Impact driver for biodiversity loss: According to IPBES[45], changes in land use and sea use, direct resource exploitation, climate change, pollution and the introduction of invasive alien species, among others, are major causes for the loss of species, ecosystem degradation, and decline in ecosystem services.

Land use (IFVI Definition)[46]: *"Broadly, land use is defined as land that is being used for production or industrial processes, which has been changed from the pristine land it would have been before human use. The land use value factors in this [IFVI] methodology specifically value the ecosystem services lost due to land use change in a given year (i.e., the difference in value between the ecosystem service provided by a pristine biome and a changed land use)."*

Land conversion (IFVI Definition)[47]: "*Land conversion is the specific act of converting land from its pristine state to a state used for industrial or productive purposes. The land conversion value factors represent the total value of future lost ecosystem services as a result of conversion in the present year. This is seen as distinct from the land use value factors as the*

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[44] According to the UN Convention on Biological Diversity (CBD) biological diversity is the "… variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems."

[45] IPBES (2019) Global Assessment. URL: https://www.ipbes.net/global-assessment

[46] IFVI (2024) Interim Methodology on Land Use and Conversion.

[47] IFVI (2024) Interim Methodology on Land Use and Conversion.

use factors represent opportunity cost in a given year, whereas conversion is over multiple years."

Mean Annual Increment (MAI): MAI relates to the growth of trees in plantations and is the average annual volume of gross increment (i.e. increase in wood volume from tree growth). MAI is measured in forest growth in wood volume (m3) per hectare (ha) per year (a).

Nature: Nature comprises the living and non-living fabric of our planet and underpins human wellbeing and the economy. Nature includes biodiversity, geology, hydrology, oceans, the atmosphere, climate and their interactions.

Net Annual Increment (NAI): NAI relates to the growth of trees and is the average annual volume of gross increment (i.e. increase in wood volume from tree growth) less that of natural losses on all trees (i.e. volume of wood loss from tree decay). NAI is measured in forest growth in wood volume (m3) per hectare (ha) per year (a).

8. Appendix B: Life Cycle Assessment (LCA) conversion factors

Appendix Table 1: Conversion of wood product (metric t) into volume raw timber equivalents (m^3) (without bark)

Resource Use: Wood		
Wood products	**Definitions**	**Conversion of wood product (metric t) into volume raw timber equivalents (m^3) (without bark)**
Industrial roundwood	All roundwood under bark (i.e. excluding bark) intended for industrial uses except wood fuel. Also described as wood in the rough. It consists of sawlogs and veneer logs; pulpwood, round and split; and other industrial roundwood. Source: FAO et al. 2022; Beck-O'Brien et al. 2022	1.33 Source: FAO 2012
Paper/Carton	Includes a broad range of paper, carton and paperboard. Source: FAO et al. 2022; Beck-O'Brien et al 2022; O'Brien and Bringezu 2018	3.45 Source: O'Brien and Bringezu 2018
Wood fuel (incl. pellets)	Roundwood that will be used as fuel for purposes such as cooking, heating or power production. It includes wood harvested from main stems, branches and other parts of trees (where these are harvested for fuel) and wood that will be used for the production of charcoal (e.g. in pit kilns and portable ovens), wood pellets and other agglomerates. Source: FAO et al. 2022; Beck-O'Brien et al. 2022; O'Brien and Bringezu 2018	1.38 Source: FAO 2012
Wood material (general)	Materials made of wood including particle board, OSB and plywood. Source: O'Brien and Bringezu 2018	1.54 Source: FAO 2012
Other	Any other wood material. Source: O'Brien and Bringezu 2018	1.53 Source: O'Brien and Bringezu 2018

Appendix Table 2: Conversion of volume raw timber equivalent (m^3) into raw timber with bark

Resource Use: Wood		
Conversion in raw timber with bark	**Definition**	**Conversion of volume raw timber equivalent (m^3) into raw timber with bark**
Raw timber equivalents (over bark)	About 12% of the volume of harvested logs is lost, when the bark is being removed after harvest. Source: FAO et al. 2020 Beck-O'Brien et al. 2022;	1.12 Source FAO et al. 2020

Appendix Table 3: Conversion of volume raw timber equivalents (m^3) into area of land used to grow the timber ($m^3/ha/a$) using average values for Net Annual Increment (NAI) and Mean Annual Increment (MAI) for different forest types.

Resource Use: Wood		
Forest growth (annual increment)	**Definition**	**Conversion of volume raw timber equivalents (m^3) into area of land used to grow the timber ($m^3/ha/a$)**
Net Annual Increment (NAI)	The Net Annual Increment (NAI) of a production forest is the net forest growth in wood volume (m^3) per hectare (ha) per year (a). Source: Beck-O`Brien et al. 2022; O'Brien and Bringezu, 2018;	NAI global average = 2.5 $m^3/ha/a$ Beck-O`Brien et al. 2022 NAI Europe = 5.9 $m^3/ha/a$ O'Brien and Bringezu, 2018;
Mean Annual Increment (MAI)	Mean Annual Increment (MAI) of a plantation is the mean forest growth in wood volume (m^3) per hectare (ha) per year (a). Source: Beck-O`Brien et al. 2022; O'Brien and Bringezu, 2018;	MAI global average = 9.3 $m^3/ha/a$ O'Brien and Bringezu, 2018;
Mean Annual Increment (MAI) of certified wood	Own assumptions: Certified wood is more likely to originate from faster growing, managed forests and plantations. Hence the MAI is likely to be in a higher range for global averages.	Certified wood (world) MAI = 5.9 $m^3/ha/a$ (Own assumptions)
Net Annual Increment (NAI) non-certified wood	Own assumptions: Non-certified wood is likely to originate from different forest types more closely related to the global average NAI.	Non-certified wood (world): NAI = 2.5 $m^3/ha/a$ (Own assumptions)
Mean Annual Increment (MAI) of certified Paper/Carton	Own assumptions: Certified wood for Paper/Carton is likely to originate from fast growing plantations. Hence the MAI is likely to be in a higher range for plantations.	Certified wood for Paper/Carton MAI = 9.3 $m^3/ha/a$ (Own assumptions)
Mean Annual Increment (MAI) of non-certified Paper/Carton	Own assumptions: Non-certified wood for Paper/Carton is likely to have a higher share of wood originating from any forest type, with a NAI closer related to global averages.	Non-Certified Wood for Paper / Carton NAI = 2.5 $m^3/ha/a$ (Own assumptions)

Appendix Table 4: Monetary valuation of land use (hectare) for forestry valued in terms of change in ecosystem services (USD/hectare)

Resource Use: Wood		
Monetary valuation of land use for forestry	**Definition**	**Monetary valuation of land use (ha) for forestry valued in terms of change in ecosystem services (USD/ha)**
Monetary valuation of land use and conversion for forestry	The impact of 1**) land use for forestry** and 2) **conversion of forests (deforestation)** is valued based on the changes in ecosystem services, using the respective value factors of the IFVI interim methodology. The IFVI value factors are developed based on the Ecosystem Service Valuation Database (ESVD) and generalized for biomes and countries using the IVFI Interim Methodology on Land Use and Conversion (IFVI 2024). Source: IVFI Interim Methodology on Land Use and Conversion (IFVI 2024).	For value factors on land use (forestry) and conversion (deforestation) for specific biomes and countries, please consult the IVFI Interim Methodology on Land Use and Conversion (IFVI 2024).

Sources Appendix B:

Beck-O'Brien, M., Egenolf, V., Winter, S., Zahnen, J., Griesshammer, N. (2022). Everything from wood – The resource of the future or the next crisis? How footprints, benchmarks and targets can support a balanced bioeconomy transition. WWF Germany. URL: https://www.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/Wald/WWF-Study-Everything-from-wood.pdf

FAO, ITTO and United Nations (2020) Forest product conversion factors. Rome, Italy, 2020. doi: 10.4060/ca7952en

FAO, 2012. Yearbook of forest products 2010. FAO Forestry Series No. 45 and FAO Statistics Series No. 201. Rome, Italy.

IVFI (2024). Interim Methodology. Land Use and Conversion. Environmental Topic Methodology. International Foundation for Valuing Impacts, Inc. (IFVI). URL: https://ifvi.org/methodology/environmental-topic-methodology/interim-methodologies/download-the-interim-methodologies/?submissionGuid=e6dbd4d1-1f62-4e4a-813f-fa9dccaf8636#InterimMethodology

O'Brien M. and S. Bringezu (2018) European Timber Consumption: Developing a Method to Account for Timber Flows and the EU's Global Forest Footprint. Ecological Economics, vol. 147, pp. 322–332. doi: 10.1016/j.ecolecon.2018.01.027

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