INTERIM METHODOLOGY

Land Use and Conversion

Environmental Topic Methodology

The International Foundation for Valuing Impacts, Inc. (IFVI) is a section 501(c)(3) public charity dedicated to building and scaling the practice of impact accounting to promote decision-making based on risk, return, and impact.

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Executive Summary

- The Interim Land Use and Conversion Topic Methodology can be used by preparers of impact accounts to measure and value the impact of air pollution on people and the natural environment. The Interim Land Use and Conversion Methodology can also be applied by users of impact information to manage the sustainability-related risks, opportunities, and impacts of an entity and inform decision-making regarding an entity's contribution to sustainability.

- To use this methodology, preparers should:

  - develop a full accounting of land use and conversion across the entity's own operations as well as upstream and downstream in the value chain, considered separately;

  - categorize land use and land conversion per location and per type of land change

  - utilize the impact pathway and value factors developed in this methodology to convert land use and conversion into impact accounts;

  - present any related impact information with supplemental notes and qualitative commentary necessary to meet the qualitative characteristics of impact information.[1]

- **Section 1** introduces the purpose of the document, outlines key concepts and definitions, and defines the scope for the Methodology. As an interim methodology, the Interim Land Use and Conversion Methodology complements official impact accounting methodologies produced by IFVI in partnership with the Value Balancing Alliance, and will be revised as part of the official Due Process Protocol with oversight from the Valuation Technical Practitioner Committee.

- **Section 2** develops the impact pathway for the Methodology, consisting of inputs, activities, outputs, outcomes, and impacts. The main impacts of land use and conversion occur through changes in the provision of ecosystem services.

- **Section 3** establishes the data required from the entity to implement the Methodology. This includes land use and conversion in hectares, by location and land use type.

[1] See General Methodology 1: Conceptual Framework for Impact Accounting.

- **Section 4** outlines the approach of the Methodology for measuring and valuing the impacts, including identification of the value of ecosystem services and the nature of value lost through land change and conversion.

- **Section 5** articulates potential opportunities for further development of the Methodology as it proceeds through the Due Process Protocol.

- The development of this methodology builds on frameworks and protocols published by leading organizations in the impact management ecosystem and sustainability-related disclosures required by governing jurisdictions and international standard setters, including:

  - Capitals Coalition;
  - Ecosystem Service Valuation Database (ESVD);
  - European Sustainability Reporting Standards (ESRS);
  - Global Reporting Initiative (GRI);
  - Intergovernmental Panel on Climate Change (IPCC);
  - National Institute for Public Health and Environment, Netherlands;
  - The Transparent Project;
  - Value Balancing Alliance
  - World Resources Institute (WRI); and
  - World Wide Fund for Nature (WWF).

1 Introduction

1.1 Document purpose

1. The purpose of this document is to outline the Interim Topic Methodology for Land Use and Conversion (henceforth, the Interim Land Use Methodology or the Methodology).

2. Interim methodologies have been released by the International Foundation for Valuing Impacts as complements to the official *impact accounting methodology* being developed by the International Foundation for Valuing Impacts and the Value Balance Alliance. The content of the Interim Land Use Methodology builds on the General Methodology and is intended for use alongside other Interim, Topic, and Industry-specific Methodologies.

3. The impact accounting methodology measures and values the *impacts* of corporate entities (entities or an entity) in monetary terms for the purposes of preparing impact accounts and generating impact information. The Interim Land Use Methodology can be used to inform internal decision-making, investment decisions, and understand the significance of waste impacts of an entity.

4. Interim methodologies have undergone a detailed research and development process, but have not gone through the Due Process Protocol or been approved by the Valuation Technical and Practitioner Committee (VTPC). Interim methodologies will be further developed and revised through the Due Process Protocol according to the established annual VTPC work plan.

5. The Interim Land Use Methodology can be applied via this document and the Global Value Factors Database. Supporting resources include the Interim Land Use and Conversion Model and the Interim Land Use and Conversion Model Technical Manual for users interested in understanding and expanding the interim methodology at a more technical level.

6. Preparers of impact accounts should adhere to the Interim Land Use Methodology to the fullest extent possible and should disclose any deviations from it when shared with users of impact information.

1.2 Topic description

7. Natural land areas, often rich in biodiversity, provide essential services to society, with changes to such environments negatively impacting society through economic, health and cultural losses. Healthy and biodiverse ecosystems provide essential services to society, such as regulating our natural environment, providing goods that support

livelihoods, offering opportunities for recreation and tourism, and providing cultural and spiritual enrichment.

8. Yet, 75% of the land-based environment has been significantly altered by human activities[2], with important social and economic implications for current and future generations. This decline in ecosystem functionality already costs the global economy more than $5 trillion in the form of lost natural services.[3]

9. Most corporate activities, from the goods that they procure to developments they enact, will have some impact on land. Food and agricultural processes drive more than 50% of the man-made pressure on biodiversity, with infrastructure and mobility responsible for a further 25%.[4] This methodology estimates the value of lost ecosystem services associated with the conversion and occupation of land and the associated lost ecosystem services that result from such activities.

10. The Interim Land Use Methodology takes a societal perspective and not the perspective of a discrete affected stakeholder group. By measuring and valuing the impacts on society, land use impact accounts can provide guidance to entities to manage and mitigate risks.

1.3 Key concepts and definitions

11. For the purposes of applying the Interim Land Use Methodology, the following terms are defined as:

    a) **Land use**: 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 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).

    b) **Land conversion:** 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

[2] See IPBES (2019).

[3] See Boston Consulting Group (2021).

[4] See Boston Consulting Group (2021).

the land use value factors as the use factors represent opportunity cost in a given year, whereas conversion is over multiple years.

c) **Biome:** An area that is classified according to its temperature range, species type, and amount of water and light received[5]. The six biomes used in this methodology are: Tropical Forests, Temperate / Boreal Forest, Grasslands, Desert / Arid Grassland, Inland Wetlands and Coastal Wetlands.

d) **Pristine state:** An environmental state that has received no anthropogenic interference, or in other words, humans have not affected the condition of the environment.

e) **Ecosystem services:** The benefits that ecosystems provide to humans, directly and indirectly, that contribute to the quality of life and well-being. Ecosystem service values differ between biomes and are used to quantify the 'value' of impact when ecosystem services are lost in conversion from pristine lands.

1.4 Scope and assumptions

12. The Interim Land Use Methodology distinguishes between use (occupation) of already-converted land and new conversion of natural ecosystems.

    a) **Land use:** The land use value factors are used in cases where entities are occupying land but conversion of that land has occurred. This land likely was previously converted, but the conversion was not attributable to the entity. Any raw materials that are being extracted from a managed land, or footprint of buildings, of the entity could be captured with these value factors.

    b) **Land conversion:** The land conversion value factors are used in cases where land has been converted from natural land into managed land and attributed to the entity. Land conversion assesses the total impact, in lost ecosystem services, of that converted land, discounted to net present value (NPV).

[5] See National Geographic Society – Biomes (2024).

Box 1: Illustrative difference between land use and land conversion

Figure 1 illustrates the conceptual difference between land use and land conversion. The first column shows the total ecosystem service value provided by 1 ha of natural land, for example, a tropical rainforest. This land is converted in Year 0 to, say, a field of wheat, and the entity then uses that land to harvest wheat in Year 1. The difference between the ecosystem services the pristine land provided, and the converted land now provides, is the land use value factor. The land use value factor represents the opportunity cost of using the land as a field of wheat instead of a tropical rainforest in that given year.

The land conversion factor represents the total value of ecosystem services lost until that area of land could theoretically provide the pristine state ecosystem services again. In other words, the entity responsible for the conversion is consequently responsible for the loss of all ecosystem services that would have been provided by that pristine state over future years. Only once the land was back to its pristine state, i.e., the converted land is allowed to regenerate, would the full ecosystem services be felt again. Each year as more land regenerates, more ecosystem services are provided, hence the increase in values from Year 2 onwards. The conversion coefficient is therefore the total value of lost ecosystem services until the land could theoretically regenerate (this methodology assumes this takes 100 years) and discounted to reflect the higher value society places on lost services today.

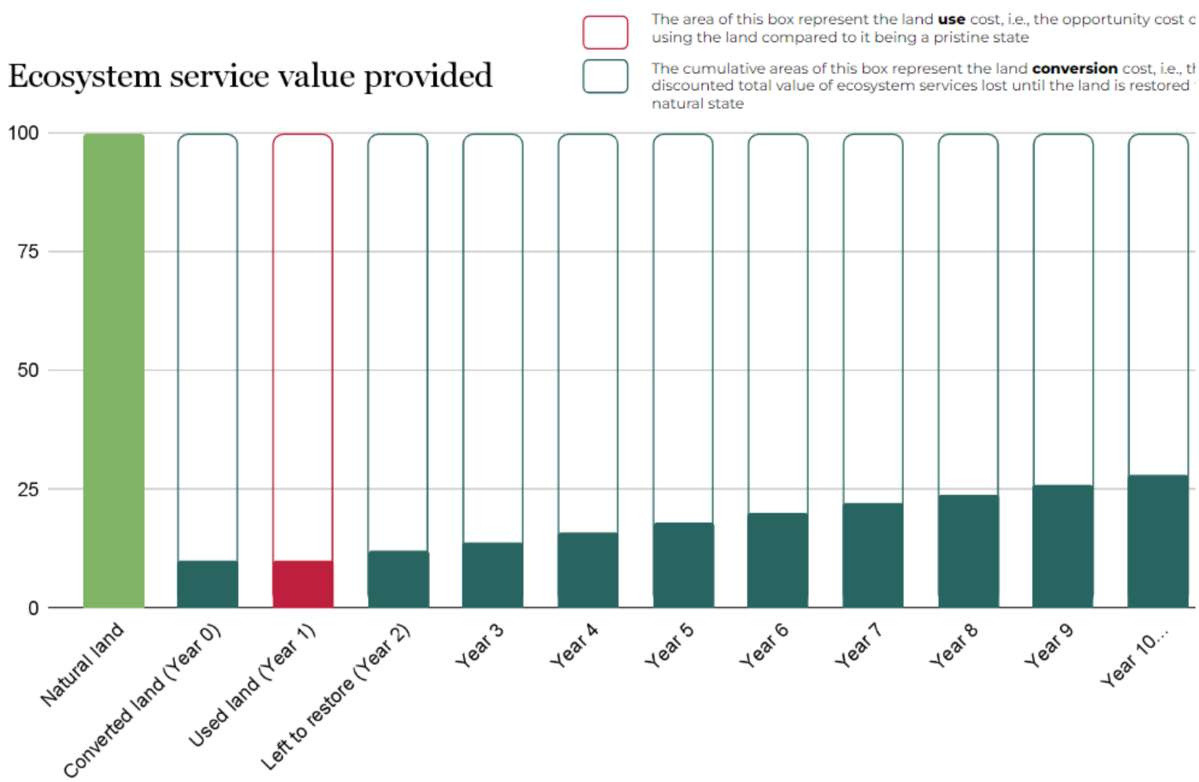

Figure 1: illustrative difference between land use and conversion

13. The Methodology covers the ecosystem service types contained within the Ecosystem Services Valuation Database[6] (ESVD), as presented in Table 1.

Service class	Specific ecosystem services	Geographical scope
Cultural	Opportunities for recreation and tourism	Local
	Aesthetic information	Local
	Inspiration for art, culture and design	Local
	Spiritual experience	Local
	Information for cognitive development	Local
	Existence, bequest values	Global
Provisioning	Medicinal resources	Local
	Food	Local
	Raw materials	Local
	Water	Local
	Ornamental resources	Local
Regulating	Climate regulation	Global
	Moderation of extreme events	Global
	Maintenance of genetic diversity	Global
	Maintenance of life cycles	Global
	Genetic resource	Global

[6] See Brander et al (2024).

	Erosion prevention	Local
	Waste treatment	Local
	Regulation of water flows	Local
	Maintenance of soil fertility	Local
	Pollination	Local
	Air quality regulation	Local
	Biological control	Local

Table 1: Ecosystem services valued in the Interim Land Use Methodology

14. The ESVD distinguishes between final ecosystem services that directly benefit people (including both use and non-use values) as well as intermediary or supporting ecosystem services (which support the provision of final ecosystem services). Only final ecosystem services are included in this methodology as the inclusion of intermediary or supporting services would lead to double counting[7]. Supporting services include those that are necessary for all other ecosystem services to function, such as habitat provision, but if included these values would be double counting the value of ecosystem services that are underpinned by the supporting services.

15. The extent to which people are affected by losses of ecosystem services will depend on the geographical scale at which these services operate. For example, harvesting of food and fiber from natural areas tends to benefit local populations, whilst climate regulation is a global benefit. This geographical scope (Table 1) defines the population impacted as a result of ecosystem loss.

16. The scope and boundaries of the Interim Land Use Methodology includes full value chain land use and conversion. This includes upstream, direct operations, and downstream as defined in General Methodology 1. An entities' own operations should be the same scope used for financial statements to ensure comparability. Value chain land use and conversion production may be based on models and not directly measured due to the challenges of measuring upstream and downstream data.

[7] See Haines-Young, R. and Potschin, M. (2017), Common International Classification of Ecosystem Services (CICES).

17. The Interim Land Use Methodology recognizes full responsibility of an entity for its upstream and downstream waste production. Land use and conversion is attributed to an entity through physical or economic relationships by portioning the inputs or outputs of land use and conversion and determining the portion that is linked to the entity. The inclusion of value chain land use and conversion means that double counting will occur if aggregating across entities in the same value chain. However, this will not lead to double counting within an individual entity's impact statement.

18. This methodology follows an ecosystem approach[8] by valuing services provided by the ecosystem, rather than individual constituents of a specific ecosystem itself. This is generally accepted[9] as the most robust approach to the measurement of societal values relating to land use changes. However it is an evolving approach with several key considerations:

    a) The ecosystem services set out in Table 1 are a significant simplification of the many and varied benefits that society receives from the environment, so any valuation of this will itself be a simplification of reality.

    b) Methods for valuation of ecosystem services are evolving rapidly and the choice of method can have a significant impact on the resulting valuation. Even basic alignment of ecosystem service classifications across frameworks, concepts, and definitions is imperfect.[10]

    c) Even if alignment between frameworks, concepts, and definitions were perfect, the difficulties that ecologists face in linking changes in ecosystems with changes in the provision of services mean that ascribing precise values to marginal changes in ecosystems remains some way off in the future.

    d) The Methodology uses a 'counterfactual' of the ecosystem service value provided by the so-called 'pristine' biome of a region, i.e. the theoretical biome that would exist without human alteration or use of the land.

19. Based on the above, the Methodology covers the use value society gains from ecosystems (such as climate regulation, food, and fuel) and non-use values (such as cultural experiences and education). It does not aim to quantify the intrinsic 'value' of nature outside of the realm of human preferences.

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[8] See Convention on Biological Diversity – Ecosystem Approach (2024).

[9] See The Ecosystem Approach, The Parliamentary Office of Science and Technology Postnote (2011).

[10] La Notte et al (2017).

2 Impact Pathway

2.1 Summary

20. The impact pathway is the series of consecutive, causal relationships, starting at an input for an entity's activities and linking its actions with related changes in people's well-being. It serves as the foundation of the impact accounting methodology

21. Detailed components of the impact pathway are outlined in subsequent sections, leading to the valuation of an entity's land use and conversion in *Section 4: Outcomes, Impacts, Valuation.*

22. The impact pathway for the Methodology is as follows:

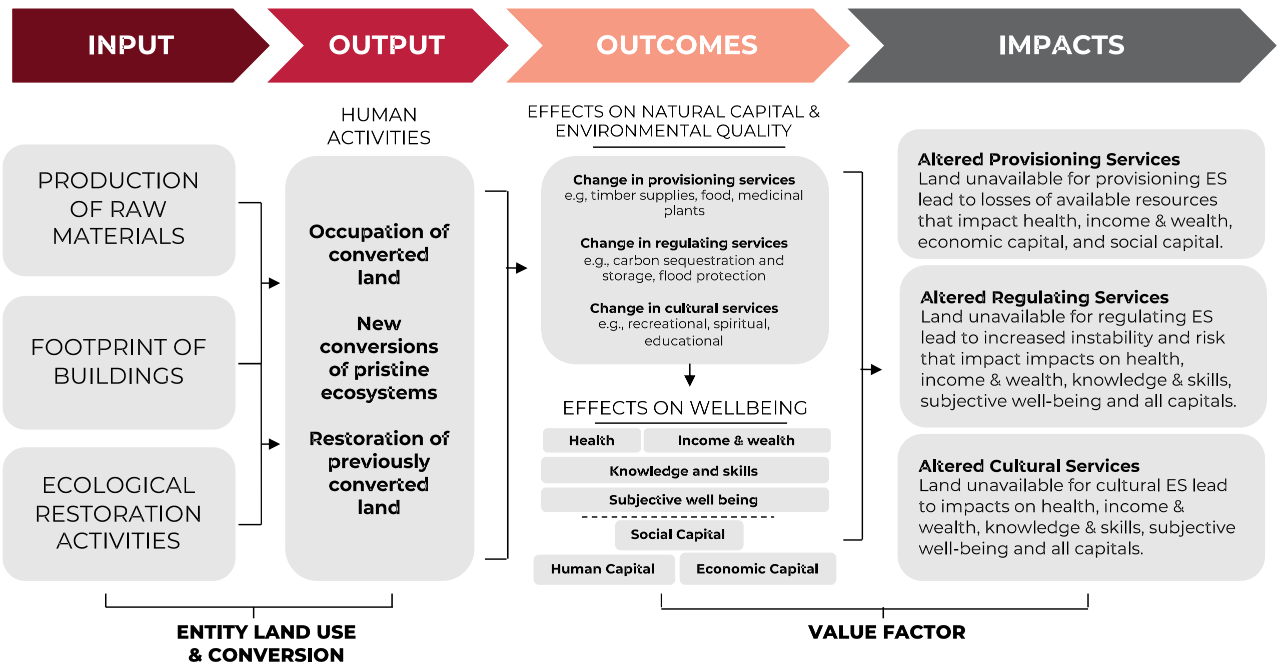

Figure 1: Land use and conversion impact pathway

2.2 Description and notes

23. The primary inputs for land use and conversion are production of raw materials and industrial footprint across the entity's own operations and value c. As these are the main drivers of land use and conversion, most corporate activities — from the goods that an entity procures to developments that entities enact — will generate impact on land.

24. The outputs of the entity are (1) the use of converted land, (2) new conversions of pristine ecosystems, or (3) in cases where restoration activities are undertaken, restoration or enhancements of previously converted land.

25. The occupation and conversion of land alters the physical environment and reduces (or in cases of restoration, increases) the amount of ecosystem services provided by the land. These ecosystem services include changes in provisioning services, such as food and fibers, changes in regulatory services, such as carbon sequestration and storage, and change in cultural services, such as recreation and education. The impact pathway and the value factors in the Global Value Factors Database cover the use of land, rather than restoration, as this is expected to be the principal impact created.

26. These changes to the physical environment drive numerous impacts that alter the condition of the natural environment and the well-being of people. These include economic impacts from reduced ecosystem productivity, health impacts from altered assimilation capacity of air and water, and cultural impacts from reduced recreational services (see Table 1 for a full list of ecosystem services included in the model).

27. The Interim Land Use Methodology is unique from some other Topic Methodologies in that the effect on humans (i.e., the impacts) are not individually valued. Rather, it takes the value of ecosystem services lost (i.e., the outcomes). Within these total value of ecosystem services lost, the impacts on humans have been valued, implicitly or explicitly, by the studies included in the ESVD repository. Using an econometric approach to value impacts would theoretically be possible, however the number of relevant variables is large, each with limited explanatory power to identify a systematic relationship[11].

28. 'Cultural impacts' refers specifically to the cultural value derived from ecosystem series, rather than land access or rights (although access and rights to land can be important for accessing and benefitting from ecosystem services).

[11] Van der Ploeg (2010) come to the same conclusion with their analysis of the TEEB database, the predecessor to the ESVD database.

3 Impact Driver Measurements

29. Impact drivers consider inputs and outputs and reflect the data needs expected of a preparer to provide an impact account for land use and conversion. The section below outlines the specific data needed along with how preparers should consider data gaps and uncertainty.

3.1 Data requirements

30. The Interim Land Use Methodology requires the total hectares of land that an entity uses and has converted, organized by the raw material provided by the land (outlined below), the country in which the materials originate from, and whether the entity has converted this land itself or is occupying previously converted land.

Data input		Country	Country 2	Country 3
Land Use or Conversion in Own Operations				
Hectares of Land Used / Converted	Wheat	/	/	/
	Vegetables, fruits, nuts	/	/	/
	Cereals, grains	/	/	/
	Oil seeds	/	/	/
	Sugarcane, sugar beet	/	/	/
	Plant-based fibers	/	/	/
	Other crops (conventionally, organic or sustainably farmed)	/	/	/
	Bovine, sheep, goats, horses (conventionally, organic or sustainably farmed)	/	/	/
	Cashmere (conventionally,	/	/	/

	organic or sustainably farmed)			
	Forestry	/	/	/
	Paddy rice	/	/	/
	Paved (buildings)	/	/	/
Land Use or Conversion in Upstream Value Chain				
Hectares of Land Use / Converted	Wheat	/	/	/
	Vegetables, fruits, nuts	/	/	/
	Cereals, grains	/	/	/
	Oil seeds	/	/	/
	Sugarcane, sugar beet	/	/	/
	Plant-based fibers	/	/	/
	Other crops (conventionally, organic or sustainably farmed)	/	/	/
	Bovine, sheep, goats, horses (conventionally, organic or sustainably farmed)	/	/	/
	Cashmere (conventionally, organic or sustainably farmed)	/	/	/
	Forestry	/	/	/
	Paddy rice	/	/	/

	Paved (buildings)	/	/	/
Land Use or Conversion in Downstream Value Chain				
Hectares of Land Use / Converted	Wheat	/	/	/
	Vegetables, fruits, nuts	/	/	/
	Cereals, grains	/	/	/
	Oil seeds	/	/	/
	Sugarcane, sugar beet	/	/	/
	Plant-based fibers	/	/	/
	Other crops (conventionally, organic or sustainably farmed)	/	/	/
	Bovine, sheep, goats, horses (conventionally, organic or sustainably farmed)	/	/	/
	Cashmere (conventionally, organic or sustainably farmed)	/	/	/
	Forestry	/	/	/
	Paddy rice	/	/	/
	Paved (buildings)	/	/	/

Table 2: Land use data requirements

31. The most influential factor in determining the environmental outcomes associated with land use is the raw material that is produced from the land, along with the country in which the produce comes from. It is therefore important to understand where the raw materials come from, along with how much land would be used to produce that

quantity. As it is likely the hectares of land used along an entity's supply chain will not be known, and difficult to obtain, these can be estimated using yield to hectare conversion factors.

32. The data requirements of the Interim Land Use Methodology are aligned with and expand upon disclosure requirements established by relevant standard setters including European Sustainability Reporting Standards E4: Biodiversity and Ecosystems and the Global Reporting Initiative 304: Biodiversity 2016. Additional alignment may exist with other regional or topic specific reporting standards as well.

Metric	ESRS	GRI
Land Use and Conversion – own operations	Expands upon E4-5, paragraph 35 and 38, page 132	Expands upon Disclosure 304-1 (a) and Disclosure 304-2 (a)
Land Use and Conversion – value chain	Expands upon E4-5, paragraph 35, page 132	Expands upon Disclosure 304-1 (a)
Location of Land Use and Conversion	Independent from E4-5, paragraph 35, page 132	Independent from Disclosure 304-1 (a)

Table 2: Alignment with reporting standards[12]

3.2 Data sources, gaps, and uncertainty

33. Preparers should strive to measure land use in a manner that is complete, neutral, and free from error. This includes faithfully representing the land use from all parts of the value chain.

34. In practice, obtaining full value chain land use data may be challenging for entities, particularly from upstream or downstream in the value chain. Barriers such as cost, accounting methods, or availability of data may limit preparers from measuring, in their entirety, land use impacts.

35. To determine land use, knowledge of an entity's own physical operational footprint, as well as that of their suppliers, is needed. Land use footprint of an entity's own operations should be available from company management information. Land use

[12]Categories of alignment include (1) fully aligned: data from reporting can be used as is for preparation of impact accounts; (2) expands upon: data from reporting conceptually aligns with the impact accounting methodology, but additional detail, context, or presentation is necessary for an accurate accounting of impact; or (3) independent: Data needed for the preparation of impact accounts are not covered by the reporting standards and would require separate data collection and analysis.

footprint of immediate suppliers and upstream supply chain is likely harder to obtain; where this is unavailable, gaps in metric data can be filled using modelling techniques such as life-cycle assessment or environmentally extended input-output modelling. Both approaches have developed frameworks for determining land use but may differ in levels of data specificity or considerations depending on the context of application.

36. The types of raw materials produced from the land will need to be established, along with the source location of these materials. This may be known by the entity or obtained from suppliers. Where data is not available, production models or trade data (including environmentally extended input-output modelling) can be used to identify the most likely source locations.

37. The availability of actual (rather than modelled or estimated) metric data will vary according to the company's level of control over the producers and users of this information. This is likely to vary across a company's value chain as described below:

    a) **Own operations:** Land use footprint of buildings should be available from company management information.

    b) **Immediate suppliers:** Land use footprint of buildings may be available from suppliers. Where this is unavailable, gaps in metric data can be filled using modelling techniques such as EEIO.

    c) **Upstream / supplier data:** Footprint of buildings can be estimated using EEIO and LCA (or inferred from other suppliers). Land use footprints of raw materials can be estimated using production models, based on data on raw material demand from the company and its manufacturing suppliers. The source location of these materials may be known by the company. If this is not the case, suppliers may be able to provide the information or trade data can be used to identify the most likely sources.

    d) **Downstream / use phase:** Land use area is highly dependent on the product in question. Cars require car parks and garages. However, many products such as clothing or cosmetics have no direct land use requirements. Indirect land use (e.g. rubber production for tires) can be estimated using production models, based on assumptions on the quantity of raw material used which may be available from customer surveys or industry information. EEIO and LCA can also be used to estimate indirect land use where appropriate.

    e) **End of life / reuse impacts:** Land use area can be modelled using EEIO or LCA techniques. This may be further informed by customer surveys or industry information.

38. Preparers should prioritize approaches that:[13]

a) Directly measure land use and converted over those that estimate based on calculations from activity data,

b) Utilize primary data from specific activities within a company value chain over secondary data, and

c) Consider sources of data that are of the highest quality possible.

39. High quality data sources should consider:[14]

a) Technological representativeness. Does the data match the technology used?

b) Temporal representativeness. Does the data represent the actual time or age of the activity?

c) Geographical representativeness. Does the data reflect geographic considerations of the activity?

d) Completeness. Is the data statistically representative of the activity?

e) Reliability. Are the data sets or sources dependable?

40. Other resources may provide guidance for land use estimation including the GHG Protocol Land Sector and Removals Guidance[15] and the IPCC Good Practice Guidance for Land Use.[16]

41. Uncertainty will arise when quantifying land use. Preparers should report qualitative uncertainty and, when possible, quantitative uncertainty. These may include but are not limited to propagated measured uncertainty, pedigree matrices, sensitivity analyses, or probability distributions.

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[13]Language adapted to water consumption from the Greenhouse Gas Protocol. (2011). Corporate value chain (scope 3) accounting and reporting standard.

[14]Language adapted to water consumption from the Greenhouse Gas Protocol. (2011). Corporate value chain (scope 3) accounting and reporting standard.

[15] See Greenhouse Gas Protocol (2022)

[16] See IPCC (2019)

4 Outcomes, Impacts and Valuation

42. The impacts that result from land use and conversion affect the environmental quality dimension of well-being and the well-being resource of natural capital. These are linked to the well-being of people via the impacts of ecosystem services on effects on health, economic capital, and cultural value.

43. The impact pathway in this statement has been developed using value factors that collapse the impact measurement and valuation stages into a summary value. As discussed in Section 2.2, the Interim Land Use and Conversion Model utilizes the ESVD valuation of ecosystem services to determine the value of lost services (i.e., the value of outcomes in the Impact Pathway). Combining the hectares of land being used or converted (outputs) to the value factor (outcomes and impacts) determines the negative cost of land use and conversion. Value factors are country-specific and therefore are applied to country-specific quantity data on the land area attributed to the entity per country.

4.1 How to calculate impacts

44. To determine the monetary cost of land use (Land Use ValueTotal) and land conversion (Land Conversion ValueTotal) preparers should use the following equations:

Land Use

Land Use Value$_{\textbf{Total}}$ = $\sum(Land\ Use\ Impact_{country})$ for all countries (Eq. 1)

Land Use Impact$_{country}$ = $LU\ Area_{country} * VF_{LU\ country}$ (Eq. 2)

Land Conversion

Land Conversion Value$_{\textbf{Total}}$ = $\sum(Land\ Conversion\ Impact_{country})$ for all countries (Eq. 3)

Land Conversion Impact$_{country}$ = $LC\ Area_{country} * VF_{LC\ country}$ (Eq. 4)

45. The variables for the equations are as follows:

$VF_{LU\ country}$	The value factor for land use based on the country of land use. The value factor should be obtained for each country where land is used and can be obtained from the Global Value Factors Database.
$LU\ Area_{country}$	The area of land use (ha) organized by the country where that land is used. Land use is determined by an entity and described in Section 3.1.

$VF_{LC\ country}$	The value factor for land conversion based on the country of land use. The value factor should be obtained for each country where land has been converted and can be obtained from the Global Value Factors Database.
$LC\ Area_{country}$	The area of land converted (ha) organized by the country where that land has been converted. Land conversion is determined by an entity and described in Section 3.1.

46. The land use and land conversion impact calculations are described below.

a) Determining land use impacts:

- Land use impacts are determined by multiplying the land being used, in hectares, ($LU\ Area_{country}$) by the country value factor ($VF_{LU\ country}$) where that land is used as described in equation 2. Equation 2 should be calculated separately for each location to obtain each country specific impact. After applying equation 2 for each country, the total land use impact can be determined by summing all country impacts using equation 1.

b) Determining land conversion impacts:

- Land conversion impacts are determined by multiplying the land that has been converted, in hectares, ($LC\ Area_{country}$) by the country value factor ($VF_{LC\ country}$) where that land was converted as described in equation 2. Equation 2 should be calculated separately for each location to obtain each country specific impact. After applying equation 2 for each country, the total land conversion impact can be determined by summing all country impacts using equation 1.

47. Upstream value chain, downstream value chain, and own operations of waste production should always be considered separately to increase transparency, comparability, and decision-usefulness. Additional levels of detail may be useful such as an assessment of land use or conversion organized by land types, at regional scales, or within specific value chain categories.

48. The value factors in the Global Value Factors Database cover the use of land that is negatively altered from the pristine state, as this is expected to be the principal impact created. Because these land uses and conversions lead to negative impacts to stakeholders via lost ecosystem services, the land use and conversion impacts are negative.

4.2 Outcomes and impacts

49. The Methodology presented here is intended for use with global supply chains, offering a method to calculate the impact of land use and conversion via lost ecosystem services. The approach is described below with additional methodological details available in *Appendix B: Methodological Details*.

50. For both land use and land conversion, the value of land is determined through the ecosystem services framework. This is done by using the Ecosystem Services Valuation Database (ESVD),[17] a meta-analysis of 9,500 ecosystem service estimates across 6 continents. The studies in this analysis use numerous objective and subjective well-being indicators and methods to determine impacts across 23 individual ecosystem services that fall into four broad categories – provisioning services, regulating services, habitat services, and cultural services.[18]

51. Outcomes and Impacts are assessed by first determining the value of ecosystem services from a pristine biome in that location. Then the extent of ecosystem service loss that occurs as a result of the current land use or conversion is then determined.

    a) **Pristine ecosystem service value:** The pristine natural state of an ecosystem represents the maximum ecosystem service value that could be obtained from land. For each country, this is calculated by multiplying biome areas (in hectares) by the average ecosystem service value of each biome (in $ / hectares / year, based on the ESVD[19]). In addition, the value for each country is adjusted for income, population density and rural population (in a combined scaling factor). This scaling factor reflects the assumption that highly dense countries and/or countries with high rural populations value ecosystem services more than less dense and/or more urban countries. This assumption is applied based on higher scarcity and higher opportunity cost principles.

    b) **Extent of ecosystem service lost:** We then calculate the proportion of ecosystem services that would be lost based on the conversion to specific managed land types (listed in Table 2). Three variables that mediate ecosystem service value are used as proxies to estimate ecosystem service loss: relative biomass, species richness, and soil organic carbon (SOC). The proportion of each proxy in the

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[17] De Groot, R. et al. (2012). *Global estimates of the value of ecosystems and their services in monetary units*.

[18] For definitions of these categories, see the Glossary.

[19] ESVD Summary Statistics show the mean standardized values for each selected biome and ecosystem service in international dollars / hectare / year in 2020 price levels. A common outlier exclusion rule based on a standard boxplot graph is used to remove studies that skew the value excessively.

converted land use relative to the pristine land use is used to determine the extent of ecosystem service lost.

4.3 Monetary valuation

52. Monetary valuation uses value factors to estimate the relative importance, worth, or usefulness of changes in well-being indicators in monetary terms. The valuation approach utilizes the ESVD. Because the ESVD represents a meta-analysis of 9,500 ES estimates across 6 continents, there are many valuation approaches used in this analysis. Some of the more common approaches in the database include market prices, damage costs, contingent valuation, and choice modelling.

53. The impact of land use or conversion is the ecosystem service loss (%) of the pristine ecosystem service value ($/ha). The country impact is then calculated as the average across the relevant biome types, weighted by the proportion of the country area that consists of each biome. The output from this calculation represent **the current marginal value** of ecosystem services, or in other words, the value of impacts of an additional hectare of land being converted today.

54. Land conversion changes drive ecosystem service loss impacts well into the future. This topic methodology assumes it takes 100 years for full ecosystem service recovery. The Land Conversion Value Factor conversion represents the total value of lost ecosystem services over 100 years[20] discounted at a rate of 2% to reflect the net present value of lost ecosystem services.

55. For the Land Use Value Factor, using the current marginal value is inappropriate for land that was converted in the past, for which the entity is not responsible for. The Land Use value factors are therefore calculated by taking **the average of the marginal values**. The rationale for this is depicted in Box 2. Taking the average represents the increase in scarcity that is felt as more pristine land is lost. The rationale for this is detailed further in *Appendix B: Methodological Details*.

56. It is highly likely that if an entity does convert a hectare of land, they will then use that land the following year. In such cases, the decision to use land for an additional year shifts the potential regeneration period back by one year and imposes another year of undiscounted ecosystem service loss. An entity should therefore account for this by adding another year of the current marginal value of ecosystem services lost to the Conversion Value Factor.

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[20] Based on Green Book guidance on the average time it takes for land to regenerate to its pristine state, see HM Treasury, The Green Book (2022).

Box 2: Average of marginal values

In order to calculate the average of marginal values a relationship between the extent of natural land area lost over time and the corresponding value loss associated with converting an additional hectare is assumed. Figure 1 illustrates a number of possible relationships. The graph demonstrates that, if the current marginal value (y) was applied to all areas of land use, the impact given by the area under line (i) would be a gross over-estimate. Three different curves are shown to illustrate the possible relationship: in curve A, costs increase linearly while, in B and C, the incremental costs increase slowly at first and then more rapidly as a greater total area is lost. Whilst one of these relationships may hold true, the actual relationship will differ across ecosystem services in different contexts.

Given this, a linear relationship (Curve A) is assumed in the calculations. This is a conservative approach and leads to higher estimates of potential impacts (since any other convex relationship would suggest impacts of past conversions are lower). In this instance, it is straightforward to calculate the average marginal cost, as it is half the current marginal cost.

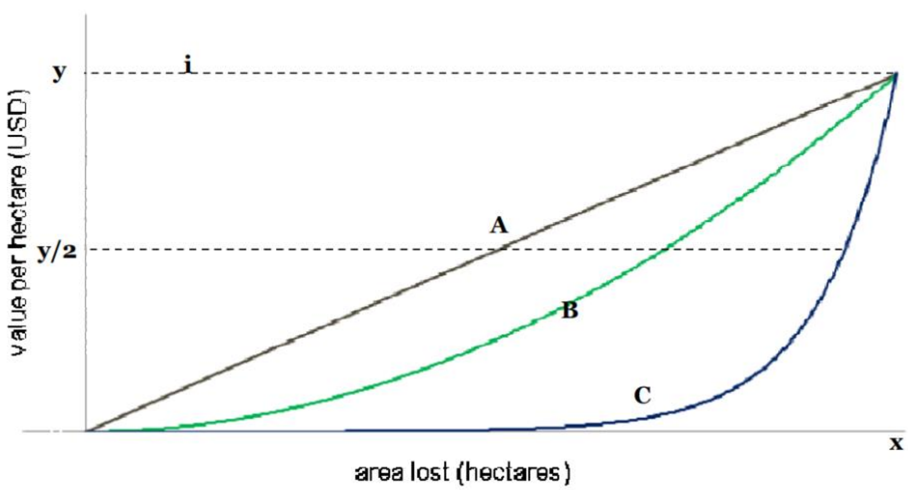


Figure 1: Ecosystem services have increasing marginal value as more natural areas are lost

5 Future Development

57. The impact pathway and valuation methods presented in the Land Use Methodology represent the current state of knowledge built upon decades of rigorous scientific work. But some limitations still exist including the ability of entities to have a complete visibility of land use across their value chain, as well as economic and ecological difficulties in estimating the true value of ecosystem services.

58. There are opportunities to further advance impact accounting by exploring new pathways that overcome limitations and reduce uncertainty. Some of these include:

    a) Development of studies and research methods that allow for more complete and accurate understanding of ecosystem service value. Valuing ecosystem services on a more granular, site-specific level would allow for more accurate quantification of impacts.

    b) Improvements in economic methods for estimating and linking the impacts of ecosystem service loss on welfare losses in society would create value factors for specific impact pathways within the Interim Land Use and Conversion Methodology, and allow for greater transparency on individual entity impacts.

    c) The development of standardized reporting frameworks specifically designed for land use across value chains would provide companies with clear guidelines and metrics to measure and report their land use impacts consistently, along with providing better visibility both up- and downstream.

    d) The integration of emerging technologies, such as remote sensing, satellite imagery, and geospatial data, could enable more accurate and efficient monitoring and assessment of land use and conversion. These technologies can provide real-time data on land cover changes, land conversion, and other relevant metrics.

    e) Improved traceability systems would help entities track the origin of their raw materials and products throughout the value chain. This would enable better identification of land use impacts associated with specific suppliers or regions, allowing for more targeted reporting and valuation of impacts.

    f) Integrating natural capital accounting approaches into corporate reporting, alongside improvements in economic valuation methods, would provide a more comprehensive understanding of the environmental and economic impacts associated with land use across value chains.

59. Further revisions based on these opportunities, among others, will be considered as the Methodology is further developed and revised through the Due Process Protocol according to the established annual VTPC work plan.

Appendix A: Glossary

Term	Definition	Source
Biomass	The total mass of organisms in a given area or volume.	National Geographic Society
Discount factor	A factor used to adjust future costs or benefits to their present value, taking into account the time value of money.	US Council of Economic Advisors
Ecosystem	A biological community of interacting organisms and their physical environment.	National Geographic Society
Environmentally extended input-output modelling	An analytical framework that incorporates environmental data into economic input-output models to assess the environmental impacts of economic activities.	UNEP
Impact	A change in one or more dimensions of people's well-being directly or through a change in the condition of the natural environment.	N/A (GM1)
Impact accounting	A system for measuring and valuing the impacts of corporate entities and generating impact information to inform decisions related to an entity's effects on sustainability.	N/A (GM1)
Impact pathway	The series of consecutive, causal relationships, ultimately starting at an input for an entity's activities and linking its actions with related changes in people's well-being.	ISO 14008:2019 (GM1)

Input	The resources and business relationships that the entity draws upon for its activities.	Impact Management Platform (GM1)
Life-cycle assessment	A comprehensive analysis of the environmental impacts of a product or process throughout its entire life cycle, from raw material extraction to disposal.	EPA
Outcome	The level of well-being experienced by people or condition of the natural environment that results from the actions of the entity, as well as from external factors. Outcomes are used to describe the one or more dimensions of people's well-being that are affected by an input, activity, and/or output.	Impact Management Platform (GM1)
Output	The direct result of an entity's activities, including an entity's products, services, and any by-products.	Impact Management Platform (GM1)
Species	A group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding.	National Geographic Society
Soil organic carbon	The carbon component of organic compounds in soil, which includes plant and animal detritus, cells and tissues of soil organisms, and substances synthesized by soil organisms.	FAO

Appendix B: Methodological Details

B1. The Interim Land Use and Conversion Methodology incorporates the societal impacts associated with all land use and conversion that can be attributed to a company's operations and therefore may need to cover multiple geographies across expansive global supply chains. The valuation approach first establishes the value of a pristine biome and traces the share of land use for which the company is responsible. It then goes on to estimate the extent of service loss that occurs as a result of the change in use. An estimate of the societal impacts of these lost services is then determined in the final step.

Ecosystem service valuation module

B2. This module estimates the value of a theoretical 'pristine' biome before it has been converted to an anthropogenic use. The value of an ecosystem is driven by the different ways in which its services provide benefits to society. The total value of a hectare of a given ecosystem is the sum of the value derived from each of the ecosystem services it provides. These individual ecosystem service values are obtained from the ESVD Summary Statistics.

B3. ESVD is a repository of over 10,000 value records across 2000 studies,[21] which estimate the value of specific ecosystem services for different biomes across the globe. These values are summarized into summary statistics providing the mean standardized values from the studies in its repository across 15 biomes and 23 ecosystem services.

B4. Once the value of specific ecosystem services across biomes has been established, values are assigned to the six biomes that form the outputs of the model: tropical forests, temperate / boreal forest, grasslands, desert / arid grassland, inland wetlands and coastal wetlands. Some of the biomes included in the ESVD database are excluded based on their applicability to the model (e.g., marine, subterranean, and urban biome values are excluded, for example, as they are not 'land' values or reflect the value of land already interfered with by humans).

B5. Values are then adjusted per country based on three factors:

a) **Country income:** To reflect the differing purchasing power across countries, and therefore the differing ability-to-pay for ecosystem services, the values are baselined to 2023 US dollars and then adjusted based on the purchasing power per capita of countries.

[21] See Brander et al (2024).

b) **Population density and rural distribution:** To reflect the assumption that more densely populated countries and those with higher rural populations value ecosystem services higher (as they are scarcer, benefit more people, and / or rely more heavily on the outputs of the land), a scaling factor based on these identities are applied.

c) **Biome distribution:** The values of ecosystem services per biome are apportioned to countries based on the percentage of biome that is present in each country. This reflects the value of ecosystem services that would be produced if each country was in a 'pristine state.'

B6. The final values represent the ecosystem service benefits that would be felt were every country in a 'pristine' state, as if their natural lands had experienced no conversion to an anthropogenic land use. These values then establish the value of ecosystem services lost when these lands are changed, as outlined in the next module.

Extent of ecosystem service lost module

B7. The ecosystem loss module calculates the change in ecosystem services and therefore defines the environmental outcomes of the land use in each location. The change in ecosystem service loss, expressed as a percentage, varies significantly according to the type of land use change. Where the extent of services lost can be determined directly, when exact location is known and data is available for specific estimates of ecosystem service provision, the actual service loss can, in principle, be calculated.

B8. However, for entities with large global supply chains this is likely not possible. In such cases, as with this model, the changes in relative biomass, species, and SOC expected with changes in land use can be estimated. There is ecological support for a relationship between these variables and ecosystems functioning[22], however it is recognized this is a crude approximation of the complexity of different ecological systems globally.

B9. Table 2 identifies the proxy variables used for each ecosystem service. The different combinations of biomass, species and SOC represent the variables that form a significant basis of the specific ecosystem services that would be lost were the land changed. In this case the assumption that the land is changed through agricultural production or other industrial processes, which is the case for the majority of the conventionally farmed and industrial outputs that this model provides. This means that some ecosystem services experience full loss, e.g., the ability to collect raw materials from a tropical rainforest will be fully lost if that land is turned into a wheat field. However, some services will be impacted by specific variable loss, e.g., climate

[22] Hooper et al (2005).

regulation will be primarily impacted by loss of biomass and SOC through carbon sequestration, but loss of species will have less of an impact on this service.

Service class	Specific ecosystem service	Proxy loss combinations
Cultural	Opportunities for recreation and tourism	Biomass & Species & SOC
	Aesthetic information	Full loss
	Inspiration for art, culture and design	Full loss
	Spiritual experience	Full loss
	Information for cognitive development	Biomass & Species & SOC
Provisioning	Medicinal resources	Full loss
	Food	Full loss
	Raw materials	Full loss
	Water	Full loss
	Ornamental resources	Full loss
Regulating	Climate regulation	Biomass & SOC
	Moderation of extreme events	Biomass & SOC
	Maintenance of genetic diversity	Biomass & Species & SOC
	Maintenance of life cycles	Biomass & Species & SOC
	Genetic resource	Biomass & Species & SOC
	Erosion prevention	Biomass & SOC
	Waste treatment	Biomass & SOC
	Regulation of water flows	Biomass & SOC
	Maintenance of soil fertility	Biomass & Species & SOC

	Pollination	Biomass & Species & SOC
	Air quality regulation	Biomass & SOC
	Biological control	Biomass & Species & SOC
Cultural	Existence, bequest values	Full loss

Table 2: Proxies for the relative change in ecosystem services

B10. The percentage loss of biomass and species are calculated in the same way: the estimated biomass and species richness for a changed land type (e.g. biomass density and species number in a hectare of wheat field), divided by the estimated incidence of biomass and species in a pristine biome (e.g. biomass density and species numbers in a hectare of tropical rainforest). The resulting value is the percentage of either biomass or species lost in the land conversion.

B11. SOC change is estimated through the IPCC's Land Use, Land-Use Change and Forestry guidance on SOC change factors[23]. There is, however, adjustment given if the land is assumed to employ sustainable land management practices. These are estimated through applying different factor weightings to the variables that form SOC estimates, as outlined in (b) below.

a) Percentage of SOC remaining in a managed land type is estimated using the IPCC's[24] calculations for relative carbon stock change factors. The proportion of carbon in managed land can be estimated through this equation:

$$SOC = SOC_{REF} \times F_{LU} \times F_{MG} \times F_I$$

Where:

SOC = Soil Organic Carbon stock for inventory year, metric tons C/ha

SOC_{REF} = the reference carbon stock, metric tons C/ha

F_{LU} = stock change factor for land use type

F_{MG} = stock change factor from management regime

F_I = stock change factor for input of organic matter

[23] See IPCC (2019).

[24] See IPCC (2019).

b) This equation shows that SOC stock is dependent on the type of management regime the landowner employs (alternatively, how much tillage is applied to the soil) and how much input of organic matter is utilized (alternatively, how much manure is used in farming processes). We hence differentiate between sustainable and conventional land practices by weighting these variables as shown in Table 3.

Land type	Management (tillage) factor	Input (manure) factor
Crop – conventional cultivation	Full tillage	Low input
Crop – organic cultivation	Reduced tillage	Medium input
Crop – sustainable cultivation	No tillage	High input

Table 3: Example of different factor weightings for sustainable and organic land management

B12. The extent of ecosystem service loss is therefore calculated as the percentage of biomass, species richness and remaining SOC after conversion. Where the proxy loss combinations involve more than one of those variables, a simple average is taken. Where the loss combination is full loss, it is assumed 100% of that ecosystem service value is lost.

Total lost ecosystem service value module

B13. The extent of ecosystem service loss is given as a percentage per ecosystem service, per country. These are multiplied by the value of a pristine ecosystem services, calculated in the Valuation Module. This obtains the value of ecosystem loss when a hectare of land in a given country is converted into an anthropogenic land use.

B14. These estimates calculated above represent the current marginal value of ecosystem services by country, which is the equivalent of the value lost if an additional hectare of land was converted today. This value is manipulated in two different ways in order to obtain the Use and Conversion value factors:

a) **Land use:** It would be inappropriate to apply this current marginal value to land that was converted in the past. This is because the impacts associated with additional losses in ecosystem services increase as more natural areas are converted through time. There are two factors that contribute to this: increasing scarcity value and increasing marginal damage costs associated with cumulative environmental degradation. Rather than applying the current marginal value, the appropriate measure for land converted in the past is therefore the *average* of the marginal value, as shown in Box 2.

b) **Land conversion:** To calculate the conversion value factors, the *current* marginal value of ecosystem services is discounted at a rate of 2% over a 100-year time horizon. This represents the net present value (NPV) of lost ecosystem services were a hectare of land converted today and, theoretically, then left to regenerate in the following years. This value factor therefore represents the value of lost ecosystem services felt every year until that area is restored.

B15. The full value factors for Use and Conversion are shown in the GVFD. As the conversion factors represent the total value of ecosystem services lost until the land is able to regenerate, they are much greater than the Use factors, which only represent the value of lost ecosystem services in a given year.

B16. It is highly likely that if an entity does convert a hectare of land, they will then use that land the following year. In such cases, the decision to use land for an additional year shifts the potential regeneration period back by one year and imposes another year of undiscounted ecosystem service loss. An entity should therefore account for this by adding another year of the current marginal value of ecosystem services lost to the Conversion Value Factor.

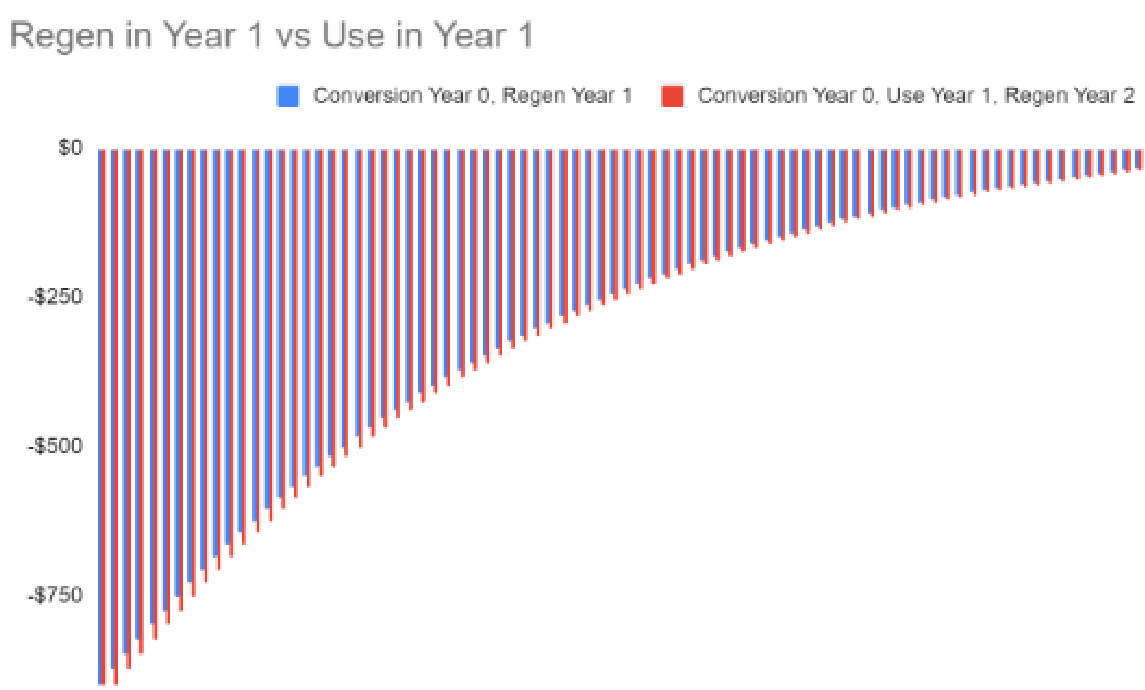
Box 3: Combining land use and land conversion coefficients

It is possible to assume that an entity using both the land use and land conversion value factors would be double counting their impact. For example, if an entity were to convert land, valuing the impact with the conversion value factor, and then value their use of the land the next year, would this be taking into account impacts that were accounted for the year before?

However, as Figure 3 shows, the decision to use the land for an additional year shifts the potential regeneration period back by one year and imposes another year of undiscounted ecosystem service loss.

The difference in total ecosystem service loss between the first and second scenario is one year's undiscounted lost ecosystem services, i.e., the land use value factor.

This is not included in the land conversion value factor so is not double counting.



Appendix C: Value Accountability Framework – Value Factors

This Appendix presents the Interim Land Use Methodology summarized in the form of the Transparency Report proposed by the Value Commission of the Capitals Coalition. Minor adaptations have been made to the report structure to align with the impact accounting methodology.

<table>
<tr><th colspan="3">Transparency Report – Value factors</th></tr>
<tr><td colspan="3">Title and version #: Interim Land Use and Conversion Topic Methodology Value Factors, Version 1

Developed by: International Foundation for Valuing Impacts

Published and updated date: October 2024</td></tr>
<tr><td colspan="3">Unit: The impact in dollars per hectare of land used for raw materials, in specific countries, along with the impact in dollars per hectare of land converted for raw materials, in specific countries.</td></tr>
<tr><td colspan="3">Linkages to other value factors: This value factor is a complement to the public good, independent, impact accounting methodology developed by IFVI in partnership with the Value Balancing Alliance and can be combined or complemented with value factors from other topic methodologies.</td></tr>
<tr><td colspan="3">SCOPE OF VALUE FACTOR</td></tr>
<tr><td>Impact pathway scope</td><td colspan="2">1. The scope of the value factor includes all land use and land conversion within the entities full value chain.

2. The value factor captures many impacts quantified by leading models while future work will continue to explore the valuation of additional impacts.

3. More detail about the impact pathway scope can be found in Section 1.4: Scope and Assumptions.

4. Application of the Methodology by an entity is based on a materiality assessment as outlined by General Methodology 1: Conceptual Framework for Impact Accounting.</td></tr>
<tr><td></td><td>ESTIMATING CHANGES IN WELL-BEING</td><td>ESTIMATING MONETARY VALUE</td></tr>
<tr><td>Approach and specificity</td><td>5. Change in well-being is estimated through the loss of ecosystem service values, with the percentage lost from a land use change proxied for</td><td>9. The value of a pristine hectare of land is gathered through the ESVD database valuations.

10. These valuations are then scaled per country based on their</td></tr>
</table>

	based on species, biomass and soil organic carbon. 6. Percentage losses are calculated for each factor of this change, e.g. the percentage loss of species that occurs when a hectare of tropical forest is converted to wheat. 7. Proxy combinations of those three factors are applied to the ecosystem services provided. These different combinations reflect which of species, biomass and soil organic carbon each ecosystem service is reliant on for its full functioning. 8. These percentage combinations reflect the loss, or change, of ecosystem services when land is converted or used.	population density, rural population and GNI PPP per capita. 11. The percentage losses are applied to the value of a pristine land to get the monetary value of what is lost when land is converted or used.
Data inputs	12. Country-specific data is taken from the World Bank and FAO. Biomass, species, and soil organic carbon data is taken from literature. 13. For further data sets see Appendix B: Methodological Details and Appendix D: Data Sources in the Interim Land Use and Conversion Methodology.	
VIEWS OF AFFECTED STAKEHOLDERS		
Representation of stakeholders	14. As an interim methodology, these value factors have yet to undergo the due process of the official methodology, which includes additional stakeholder engagement and public comment.	
ETHICAL DECISIONS IN ESTIMATING SOCIETAL IMPACT		
Equity weightings and income adjustments	15. The Land use model applies a scaling factor adjusted for country GNI PPP per capita, which reflects the differing abilities to value (or pay to protect) a pristine hectare of land's ecosystem services. Without this, poorer countries could see the value of a hectare of land being higher than the average	

	income of that country, which does not accurately reflect how society in that country would value a pristine ecosystem. 16. Ecosystem service values that provide global benefits are valued based on a global average income, as the benefits accrue to stakeholders around the world. This includes carbon sequestration benefits which have impacts across multiple generations.
Accounting for future impacts	17. Future impacts are modelled in the conversion value factors. These are discounted at a rate of 2% over 100 years.
Other ethical considerations	18. N/A
SENSITIVITY	
Sensitivity to key variables	19. Sensitivity analysis was carried out for 3 land use types (wheat, vegetables, and paved), for 3 countries (United States, China and Nigeria). For full results see Table 4.

Table 4: Sensitivity analysis

Land Use		**United States**			**China**			**Nigeria**		
Variable	Flex	*Wheat*	*Vegetables*	*Paved*	*Wheat*	*Vegetables*	*Paved*	*Wheat*	*Vegetables*	*Paved*
Average ecosystem service value	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Pristine species richness	10%	1%	0%	0%	0%	0%	0%	0%	0%	0%
Converted land species richness	10%	-1%	0%	0%	0%	0%	0%	0%	0%	0%
Rural population	10%	7%	8%	8%	6%	6%	6%	3%	4%	4%
Scaling factor (changed bounds)	15%-85% (from 25%-75%)	-1%	0%	-1%	10%	10%	10%	8%	8%	8%
Land Conversion										
Time horizon for conversion	75 years (from 100)	-15%	-15%	-15%	-15%	-15%	-15%	-15%	-15%	-15%
Discount factor	3% (from 2%)	-19%	-19%	-19%	-19%	-19%	-19%	-19%	-19%	-19%

Appendix D: Data Sources in the Interim Land Use Methodology

Data	Source[25]	Year
Above ground biomass	FAO	2015
Ecosystem service valuations	ESVD Database	2023
Biome species numbers	Kier et al. (2005)	2005
Marsh/coastal species numbers	Więski et al. (2008)	2008
Grassland/pasture species	Tracy and Sanderson (2000)	2000
Grassland/pasture species	Goslee and Sanderson (2005)	2005
Grassland/pasture species	Adler et al. (2004)	2004
Cropland species	Mehmeti et al. (2009)	2009
Cropland species	Lindstrom et al. (2008)	2008
Grassland biomass	Mbaabu et al (2020)	2024
Mangrove biomass	IPCC Wetlands	2013
Marsh biomass	Więski et al. (2008)	2009
Pasture biomass	IPCC Grasslands	2006
Crop biomass	IPCC Cropland	2006
Forest biomass	IPCC Forest Land	2006
Soil organic carbon	IPCC Cropland	2006
Koppen-Geiger	GloH20	2023
Land use biomes	WWF	2012

[25] Sources are hyperlinked for your reference.

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