TRANSPARENT

A METHODOLOGY PROMOTING STANDARDIZED NATURAL CAPITAL ACCOUNTING FOR BUSINESS

Enabling corporate practitioners to support the green transition through the use of natural capital management accounting in the EU and globally

DRAFT FOR CONSULTATION

July 2021

About this document

This draft document, developed through the EU LIFE Programme by Transparent Project, is being opened for consultation.

The document is a work in progress. Detailed feedback from a number of experts has already helped to steer its development. Input from this consultation as well as the upcoming piloting process will contribute to testing and improving the standardized approach and its documentation.

Disclaimer

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TABLE OF CONTENTS

FOREWORD

The accelerating deterioration of natural ecosystems, the loss of biodiversity and a rapidly changing climate are fundamentally changing the traditional context for business decision making. Once a fringe discussion, the role that natural systems play is now accepted in the mainstream as essential to the functioning of our economic and financial systems.

Governments, business leaders and investors across the world are increasingly recognizing their dependence on the health of natural capital, and the ways in which their impacts on nature may undermine their continued success. The urgent need for action is reflected in significant momentum globally towards better understanding, measuring and managing the role of non-financials in enterprise value. Realms of academia, finance, business and policy are all contributing to the further development and harmonization of approaches.

In Europe, the urgency of the environmental crisis has been recognized by policymakers in the Green Deal. Through a comprehensive set of policy measures, such as the Sustainable Finance Disclosure Regulation (SFDR), the Corporate Sustainability Reporting Directive (CSRD), the Taxonomy Regulation, or the work of the Joint Research Centre (JRC) around Organization Environmental Footprint (OEF) and Product Environmental Footprints (PEF), the European Commission has demonstrated its belief that a shift is required in the way that both the public and private sectors understand and account for their relationships with nature.

At the international level, the IFRS Foundation, supported by international organizations such as the G7 or IOSCO, has taken the lead to harmonize and standardize sustainability reporting in collaboration with the Value Reporting Foundation, focusing on information for financial market actors.

There are now many examples of how business has applied a multi-capitals approach to inform decisions. But even with internationally recognized harmonized frameworks such as the Natural Capital Protocol, practice to measure and steer business is not yet standardized by the application of concepts in a consistent manner.

To achieve the ambition of the Green Deal and the globally agreed UN Sustainable Development Goals, we need a robust approach to accounting for natural capital that is generally accepted and commonly used by all businesses. To support effective and informed business decision making, this approach needs to address conceptual matters and also the practical challenges of implementing natural capital accounting.

With generous funding from the EU Commission through the EU LIFE programme, the Transparent Project has brought together the Value Balancing Alliance (VBA), the Capitals Coalition and the World Business Council for Sustainable Development (WBCSD) in a public-private partnership to deliver the necessary standardization.

Through a business-led approach and building on the wealth of experience that has evolved, the consortium has developed this first draft of a standardized methodology for natural capital accounting in business which is described here.

The focus of this document is on management accounting principles, noting that good accounting information can in turn be used for external disclosure for reporting to stakeholders such as the CSRD, the Taxonomy Regulation, or the international standards.

The Transparent Project provides a major contribution to the European Commission's commitment "to support businesses and other stakeholders in developing standardized natural capital accounting practices within the Union and internationally, with the aim of ensuring appropriate transaction costs" (CSRD 2021 (38)).

Together with its sister project, Align, which will provide integrated guidance focused on the challenging natural capital aspect of biodiversity, we believe that the guidance provided through the Transparent methodology will support a more sustainable financial and economic system that delivers value for nature and people alongside business and the economy.

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0 INTRODUCTION

0.1 What is this document?

This document provides an approach to harmonize and standardize natural capital accounting for business. The focus of the Transparent methodology is application of natural capital accounting in a business decision-making context, that is, in a management accounting rather than an external reporting setting. In developing this methodology, the Transparent Project has the following guiding objectives:

- Enable decision makers to improve business decisions.
- Standardize where possible, provide guidance where needed.
- Be embedded in the broader movement, connected to existing and emerging frameworks such as CSRD and Taxonomy Regulation in Europe.
- Consider scalability and practical feasibility.

Following extensive benchmarking of tested methodologies (WBCSD 2021), the methodology sets out steps and actions for a user to apply in a pragmatic way:

- Defines the minimum that should be measured when accounting for natural capital from a corporate perspective (i.e., which indicators and impact drivers to include)
- Standardizes impact pathways for each impact driver and proposes standard (monetary) valuation approaches, where possible
- Points to key resources and methods to measure change in natural capital (where standardization is not possible or desirable)
- Shows links between business applications and provides recommendations on the use of natural capital accounting results.

Building on the Natural Capital Protocol and specifically Steps 05-07 (Figure 1), this methodology provides consistency in how business should measure and value natural capital impacts and dependencies. Box 1 provides the key concepts on natural capital accounting used in this methodology.

Figure 1. Framework of the Natural Capital Protocol

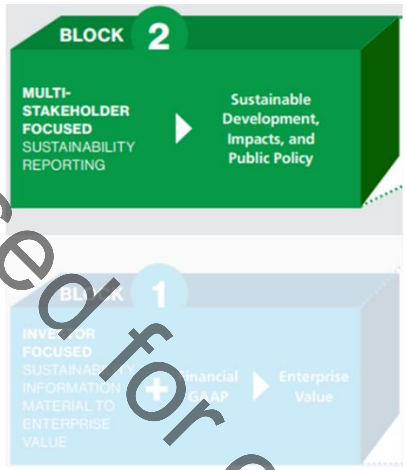
Source: Natural Capital Protocol

Note: Users should follow the actions set out in all nine Steps of the Natural Capital Protocol to frame, scope and apply an assessment.

The methodology aims to improve data quality and robustness for business decision making, noting that these improved data can, in turn, be used for external reporting to stakeholders. The approach offers a stepping-stone for moving towards a global standard to value the natural capital impacts and dependencies of business.

Following the logic of the International Federation of Accountants (IFAC) building block approach (Figure 2), there are two perspectives for sustainability information: Block 1 is concerned with the investor-focused perspective and information material to enterprise value (dependencies / impacts on business), whereas Block 2 takes a multi-stakeholder perspective (impacts on society) (IFAC 2021).

Figure 2. IFAC building blocks for a comprehensive corporate reporting system



Source: International Federation of Accountants (IFAC)

This current draft of this document only covers IFAC's Block 2 (impacts on society). Future versions of the document will also address Block 1 (dependencies / impacts on business).

Box 1. Key concepts of natural capital accounting

(Source: adapted from the Natural Capital Protocol)

Natural capital is the stock of renewable and non-renewable natural resources, both biotic and abiotic (e.g., plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people. This corresponds to "environmental assets" in the System of Environmental Economic Accounting (SEEA) framework, which takes a (macro)economic perspective based on National Accounts. Changes to natural capital may affect both the extent and the condition of natural resources.

An **impact driver** is a measurable quantity of a natural resource used or generated by business activities that leads to a change in natural capital. Impact drivers may be inputs (e.g., volume of sand and gravel used in construction) or non-product outputs (e.g., a kilogram of NO_x emissions released into the atmosphere by a manufacturing facility), sometimes referred to as "residuals".

Impacts are positive or negative contributions to one or more dimensions of well-being.

Dependencies are a business reliance on or use of natural capital. Note: In this document, interactions between different elements of natural capital are not referred to as dependencies.

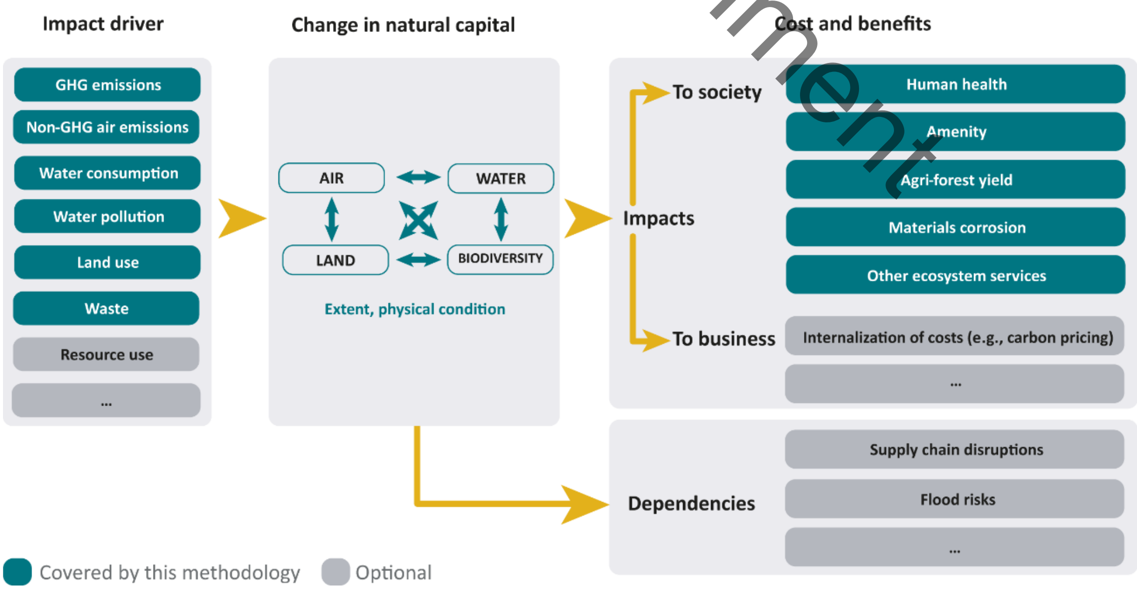
An **impact pathway** describes how, as a result of a specific business activity, a particular impact driver results in changes in natural capital and how these changes in natural capital affect different stakeholders.

Value perspective: The perspective or point of view from which value is assessed; this largely determines which costs or benefits are included in an assessment. The two main perspectives on value, which are also reflected in the concept of "double materiality", are:
Value to business: The costs and benefits to the business, also referred to as internal, private, financial, or shareholder value.
Value to society: The costs and benefits to wider society, also referred to as external, public, or stakeholder value (or externalities).

Valuation technique: The specific method used to determine the importance, worth, or usefulness of something in a particular context. This covers **qualitative** (descriptive, using categories such as high/medium/low), **quantitative** (using physical or other non-monetary units) and **monetary** (using money as the common unit) techniques.

The scope of this document includes the principal natural capital assets of air, water, land and biodiversity. Because business measure the drivers that impact these assets and the people depending on them, the methodology is structured according to impact drivers as shown in Figure 3. Impact drivers in blue boxes are covered in detail in this document. These drivers were chosen based on initial research indicating that impact pathways and (monetary) valuation approaches can be found in the literature for this selection. Other impact drivers may be significant but available literature is currently more limited. Future iterations of this approach should be opened to extending the list of impact drivers.

Figure 3: Impact drivers and pathways covered in this document



0.2 Who is this document for?

In many companies, sustainability teams bear responsibility for conducting natural capital assessments. These teams typically possess expertise on impact pathways and the links between corporate activities and impacts. However, they are not usually owners of the processes or systems needed to allow reporting data in a consistent, frequent and assurable manner. To be truly embedded in business decision making, natural capital information needs to be provided directly alongside financial and operational data.

This methodology document is intended to be used by:

- Accountants within the finance, accounting and controlling function in business. Accountants will provide the necessary data to complete this type of assessment and will also take the lead in communicating assessment results to different business functions. In the longer term, integrated accounts might be created combining financial results with human, social and natural capital accounting results.
- Executives and decision makers from key corporate functions (operations, purchasing, marketing and public affairs, R&D, etc.). They are the users of the information.

The Transparent methodology is intended to be applicable to any business sector, operating in any geography, at any organizational level.

0.3 Principles for natural capital accounting

Accounting standards broadly fall within two categories: principle-based and rule-based. Given the variety of possible applications of natural capital accounting, the Transparent methodology is grounded in a principle-based approach, building on existing frameworks where possible. Thus, this methodology follows the principles set out by the Natural Capital Protocol:

- **Relevance:** Ensure that you consider the most relevant issues throughout your capitals assessment including the impacts and/or dependencies that are most material for the business and its stakeholders.
- **Rigor:** Use technically robust (from a scientific and economic perspective) information, data, and methods that are also fit for purpose.
- **Replicability:** Ensure that all assumptions, data, caveats, and methods used are transparent, traceable, fully documented, and repeatable. This allows for eventual verification or audit, as required.
- **Consistency:** Ensure the data and methods used for an assessment are compatible with each other and with the scope of analysis, which depends on the overall objective and expected application.

Users wishing to disclose assessment results publicly should explicitly consider additional principles for financial and sustainability accounting. This is particularly relevant for users planning to integrate natural capital accounting information into existing external reporting formats such as annual, non-financial, or sustainability reports These additional principles are also important when aiming for external assurance.

The approach outlined in this document is consistent with the principles for future sustainability reporting standards outlined in Article 19b of the proposed revised EU Non-Financial Reporting Directive (NFRD), namely that sustainability information is to be understandable, relevant, representative, verifiable, comparable, and represented in a faithful manner (CSRD 2021 (19b)).

Although it is recommended that the principle of Consistency be adhered to throughout your assessment, this document does not propose that outputs be consistent and comparable between companies as specific datasets used may be different.

0.4 Decisions this methodology can inform

Natural capital accounting as outlined in this document enables better informed business decision-making by providing a means of quantifying and understanding a business' impact on and from natural capital. Potential applications, as set out in the Natural Capital Protocol, can be grouped around assessing risks and opportunities, comparing options, assessing impacts on stakeholders, estimating total value, and communicating and reporting internally and externally. The focus of this document is on business decision making, and the consistency that this methodology brings will also be helpful for external disclosures.

In business decision making, the choice of application will inform all other steps in accounting for natural capital. It will also likely impact practical considerations such as which functions within your business need to be involved, and how to link natural capital accounting to data already available within your business (e.g., from environmental management systems or procurement).

0.5 Evolving the Transparent methodology

This document focuses on quantifying the impacts that a business has on society through its use of natural capital. The impacts of the use of natural capital on the business, and business dependencies on natural capital, will be addressed in future versions of this document that will be completed before the conclusion of the Transparent Project.

A sister project, Align, is focusing on the natural capital element of biodiversity. The outputs from both – Transparent and Align – will be combined to form a comprehensive natural capital accounting method including biodiversity before the conclusion of the Transparent Project.

As part of the Transparent Project, a separate guidance document will be created on the application of natural capital accounting from a management perspective ("management blueprint"). This guidance document will address practical matters in more detail, including considerations for first-time users of natural capital accounting and recommendations for integrating natural capital accounting into business systems and processes.

1 DEFINING OBJECTIVE AND SCOPE

The focus of this document is application of natural capital accounting at the corporate level. You will define the objectives and scope of your application in more detail as outlined in this chapter. This will allow you to set up an approach for measuring and valuing impacts at the appropriate level of rigor. To enable more holistic business decision making and improve overall performance with respect to natural capital, management accounting should incorporate natural capital at additional levels, such as at the project level and investments.[1]

1.1 Target audience and stakeholders

The natural capital accounting method outlined in this document has been developed to inform top-level management as the default target audience. This follows from a focus on more holistically informing management accounting and internal decision making. Depending on your business application, additional (non-exhaustive) organizational functions may also be relevant audiences: strategy, finance, product development, research & development (R&D), operations (including resource allocation, budgeting/forecasting, etc.), sourcing, procurement, mergers and acquisitions, portfolio management, risk management, marketing, communications, and investor relations. You should liaise with all principal users of the natural capital accounting outcomes within and outside the business to understand their needs.

Besides the target audience, other internal and external stakeholders may serve a function in developing or have an interest in the outcome of your natural capital accounting or. These stakeholders fall into three broad groups including people who can:

1. Provide information and data (e.g., sourcing or procurement for supply chain information);
2. Influence the result of your natural capital accounts; or
3. Verify, validate and interpret the natural capital accounting, providing legitimacy (expert roles).

Before getting started, determine which stakeholders are most important to your objective and the appropriate level of engagement with them. Particularly if setting up regular internal reporting, integration with your existing systems landscape will be critical to the success and effectiveness of your natural capital accounting.

1.2 Scope

Organizational focus: The default organizational focus of this methodology is the corporate entity as a whole, covering the whole business, corporation or group, including all subsidiaries, business units, divisions, different geographies or markets, etc.

The organizational focus (or boundaries) should be in line with your usual financial or management accounting practice (e.g., relating to consolidation rules, joint ventures, equity stakes). This is especially important if planning to use information from your natural capital accounting to support external reporting. Depending on your business application, you may also want to consider the project and/or product level.

[1] For more details, including defining natural capital for other entities or applications, refer to the Natural Capital Protocol (Steps 02-04).

Value-chain boundaries[2]: Your natural capital accounting should cover the full value chain, and distinguish between the following three stages at a minimum:

- **Own operations**: Covers all activities within own operations over which your business has direct control. To ensure connectivity you should use the same scope as for a financial statement. Sometimes this level is also known as "direct" or "gate-to-gate".
- **Upstream**: Covers all activities, resources and products that your company has purchased from all suppliers. Sometimes this level is also known as "indirect" or "cradle-to-gate".
- **Downstream**: Covers all activities linked to direct customers (further processing), product use by end consumers and product end-of-life. Sometimes this level is also known as "indirect" or "gate-to-grave".

Depending on your application you may wish to break down the value chain levels further, for example differentiating between tier 1 suppliers with whom you have a direct business relationship and further tiers (your suppliers' suppliers) or differentiating between different parts of the downstream value chain. Table 1 provides some examples of activities **associated with natural capital impacts along the value chain.**

Table 1. Examples of activities associated with natural capital impacts along the value chain

Value chain level	Example activities associated with natural capital impacts (non-exhaustive)
Own operations	Energy consumption
	Manufacturing processes
	Transportation and logistics
Upstream	Extraction / production of raw materials
	Processing and transformation
	Transportation and logistics
	Land-use change and agriculture
	Capital goods, leased assets
Downstream	Processing of products
	Transportation and logistics
	Use of products
	End-of-life treatment (incineration, landfill, recycling, non-managed)
	Investments, leased assets, franchises, etc.

Value perspective and type of value: Following this methodology, your natural capital accounting should account for the value to society, expressed in monetary terms. You may find it useful to include further qualitative and quantitative, non-monetary value perspectives in your natural capital accounts to help you better interpret results.

Accounting period: The natural capital accounting method set out in this document seeks to be compatible with the concept and principles of financial accounting. Hence, the natural capital accounting cycle should be in line with the (annual) time period typically used in financial accounts.

[2] By analogy with the "scopes" often used in GHG emissions accounting, "own operations" corresponds to scope 1, "upstream" to scopes 2 and upstream scope 3, and "downstream" to downstream scope 3 categories.

One of the ways in which natural capital accounting differs from financial accounting is that in natural capital accounting there is often a time lag between a business activity, an impact driver, and an impact on society. For example, a company might sell a product in one year (business activity), which is used in the next year leading to GHG emissions (impact driver), which in turn contributes to climate change (impact on society). Your natural capital accounting should cover all impacts associated with activities happening during the time period of your natural capital accounting (e.g., one financial year) by default. This includes future impacts generated by activities occurring during the time period defined in the scope of your assessment. This means that the downstream impacts associated with the use of sold products should be accounted for in the year that the product is sold. Such future impacts may be discounted.

Impact drivers: At a minimum, the following impact drivers should be included by default as further specified in this document:

- GHG emissions
- Non-GHG air emissions
- Water consumption
- Water pollution
- Land use
- Waste

When a materiality analysis is carried out on these impact drivers and the relevance to your business (notably for the purpose of external reporting and disclosure), any omissions or deviations should be clearly explained and justified. It is moreover strongly recommended that you combine natural capital accounting with social and human capital accounting in your decision making. If it is not possible to quantify social and human impact drivers, it is recommended that you perform at least a qualitative analysis.

Baselines: Natural capital accounting involves measuring changes in the state of natural capital (see measure and value in chapter 2). This means that a **baseline** is required to characterize the state of natural capital without an impact driver changing it. Both the extent and quality of natural resources at a given point in time are relevant to characterize a baseline.

In general, your contribution to a change is measured through your impact drivers, and the valuation approach implicitly includes a baseline. In the case of land use, if you are occupying previously converted land, the baseline is the pristine state of nature. Again, this is implicit in the valuation approach. You do not need to define your own baseline as a default. However, you may (optionally) find it useful to define additional scenarios and baselines depending on your business application.

Scenarios (optional): When applying natural capital accounting in decision making, it is often useful to define scenarios that differ from normal operations. If using natural capital accounting for making comparisons, you should define at least one alternative scenario to compare outcomes and impacts across your alternative scenarios and the baseline. These scenarios could be "interventions" or real alternatives being considered (e.g., for comparing alternative materials used in a particular product), "exploratory" scenarios assessing possible unexpected futures, "vision" scenarios describing explicitly desirable or undesirable futures, or "counterfactual" scenarios which describe a plausible alternative state of a site and its environmental conditions that would result if the company did not operate.

Note: You can find two illustrative examples of the outputs resulting from the objective definition and scoping in Annex I.

2 MEASURE AND VALUE

To measure and value your natural capital impacts, you need to complete three steps:

- **Measure your impact driver** (Step 05 in the Natural Capital Protocol).
- **Measure the change in state of natural capital** as a result of your impact driver (Step 06 of the Natural Capital Protocol).
- **Value the impact this change in capital has on society** (Step 07 of the Natural Capital Protocol).

Note that the current version of the methodology does not include dependencies or value to business, which will be addressed in future versions.

Some aspects of natural capital accounting are cross-cutting and need to be applied consistently across all impact drivers (e.g., allocation of impacts, discounting for the future). Other aspects are specific to the impact driver under consideration. To help you undertake the three steps to measure and value natural capital impacts, this section contains:

- **General rules** applying to the measurement and valuation of natural capital. You should apply these when measuring and valuing any impact driver.
- **Specific rules** to complete the assessment of specific impact drivers. You should apply these when measuring and valuing each of the relevant impact drivers defined in this document.

Note on practical implementation and existing models

Understanding and evaluating changes in the state of natural capital and the impacts that these changes have on society requires deep expertise. Measuring and valuing natural capital impacts typically involves modeling approaches – whether this is done directly by yourself or by using external support or data sets. It is therefore highly likely that changes in natural capital are covered in models, so from a practical perspective you may not perform each of the three steps yourself.

There are different types of (external) model providers: some offer valuation coefficients that apply directly to impact drivers. In this case, changes to natural capital and impacts are implicitly covered in their assessment models, and you will not have to conduct any measurement for these in physical terms but arrive directly at valued impacts in monetary terms. Others apply monetary valuation coefficients to impacts in physical terms.

Both approaches are acceptable under this methodology. If working with external providers, ensure that you and the target audience understand their key assumptions, scope and any deviation from the methodology outlined in this document. All should be properly documented.

2.1 General rules

2.1.1 Measure your impact driver

Data

Impact drivers are typically measured in terms of physical quantities. You will need to decide which type of data source to use from the available options:

- **Primary data:** available internally in your business
- **Secondary data**: available publicly, or commercially
- **Combination of primary and secondary data**

Primary data can, in theory, deliver the most precise results and match your business activities most closely. However, in many cases for companies with international value chains, primary data may be complex or require significant resources to collect, particularly if you do not already capture these data in your systems. In some cases, you may be able to extrapolate from a smaller sample of primary data, provided that you are able to define a representative sample.

Secondary data should be used in cases where direct measurement of impact drivers is not practical. You can use different techniques that rely on secondary data, including the direct application of results from other situations, as well as adjusted estimates based on modeling. Common sources of secondary data include modeling techniques such as environmentally extended input-output models (EEIO), life cycle assessment (LCA) databases, and published, peer-reviewed literature. Table 2 provides considerations when selecting your type of data source. See Annex II for more detail on these.

Table 2. Considerations for selecting (secondary) data sources

Scientific validity	• Do the data come from a reputable source? • Have the data undergone a (scientific) peer review?
Quality assurance, controls	• Are all primary data sources and modeling assumptions used in the data source clear – and are they representative for my needs? • What kind of verification/validation/assurance process has the data source undergone (if any)? • Has this been documented (i.e., is there any assurance statement available)?
Temporal reference	• Which base/reference year does the data source refer to – and is this representative for my purposes? • Which time period do the data refer to (month/year/etc.)? • Do the data reflect seasonal variations (if relevant)?
Geographic specificity	• Does the data source offer a worldwide breakdown to (sub-)country level? • Does it adequately reflect local variations?
Technological representativeness	• Does the data source reflect the technology or processes relevant for my business?
Practical issues	• Does the data source cover all impact drivers or a limited number of them? • Is the data source updated regularly? • Can I work with the data format or is specialist software required?

Practical issues	- Can I use the data source directly or are additional modeling steps required (e.g., mapping data to categories in my systems)? - What are the costs of using the source (if any)? - Can I make any adjustments to the data myself, or will I need to rely on external support for this? - Are there any formal issues to consider (e.g., copyright, licensing)?

Attribution of impact drivers to business activities
In some cases, especially when accounting for downstream impacts from the use of sold products, impact drivers and impacts may not be attributable to your business activities alone. For example, a company producing intermediate goods that are further processed into an end product will need to account for the impacts associated with this end product, even if the company is not solely responsible for the impact. This is also true for processes generating more than one product (multiple, co- or by-products).

There are a number of different ways of partitioning or allocating inputs, outputs, and impacts in such cases of multifunctionality, for example, based on physical relationships (mass, volume, energy use), or other relationships (such as economic value). The choice of allocation method can significantly impact the results of your assessment. ISO 14044 presents a hierarchy of solutions to deal with allocation, while the EU Organization / Product Environmental Footprint (OEF/PEF) methodology provide further specific guidance. This generally applicable methodology recommends following the ISO/PEF/OEF approach.

Estimates and proxies
You may also use estimates based on intermediate or proxy indicators. These provide a useful shortcut which must then be combined with other information to measure or estimate the impact driver. For example, you may not be able to measure GHG emissions directly but could calculate them based on energy use and published emission factors. The use of estimates and proxies should be well documented to facilitate reproducibility.

Competencies and resource requirements
Unless you have in-house specialists, you may need to seek external support, especially when using environmentally extended input-output models or life cycle assessment databases. You should ensure that there is consistency of data models across different impact drivers to ensure that results are consistent. For example, if choosing to model parts of your upstream supply chain using a particular EEIO model or LCA database for GHG emissions, you should use the same model for non-GHG air emissions as well as other indicators. Any deviation from this should be justified.

2.1.2 Measure changes in the state of natural capital

Changes in natural capital are what ultimately leads to impacts on society and business. These will be highly dependent on the impact driver and impact area you are considering. For example, emitting non-GHG air emissions may lead to an increased local concentration of pollutants and hence reduced air quality. The degree to which emissions reduce air quality will be dependent on a range of factors, including local weather/climatic conditions, the presence of other substances, etc. This section is therefore kept fairly short and abstract – but more detail is found for each impact driver in sections 2.2.1-2.2.6

To measure changes in the state of natural capital, you should complete the following actions:

- **Identify changes in natural capital associated with your business activities and impact drivers for each value chain level.** Box 2 provides some considerations to guide you when identifying and selecting changes in natural capital to assess.
- **Select methods for measuring change.** Table 3 describes available methods for measuring and estimating changes in natural capital, including a brief description of their approach and considerations for their selection. You should select one of those methods. For appropriate choice of method, consider:
  - the level of detail required
  - practicability within the available time and resources
  - the geographic scope under consideration

Box 2. Considerations for identification and selection of changes in natural capital to assess

You may find it helpful to map the relevant indicators chosen in Step 05 of the Natural Capital Protocol to their impact driver categories and identify the likely subsequent changes in natural capital. For examples, see Natural Capital Protocol (Table 6.1)

The selection of specific changes in natural capital to include in your accounting will depend on available data, the cost of sourcing or modeling additional data, suitable methods, and the time and other resources available for your accounting.

The changes in natural capital to consider should be informed by your application and required level of rigor.

Table 3. Types of methods for measuring changes in natural capital and description of their approach.

Type of method	Description of method and considerations
Direct measurement methods	Measure changes directly, without using mathematical calculations.
Generalized modeling methods	Applicable to a generalized context and therefore less detailed and lower resolution than direct measurement methods. Widely available and based on established approaches such as life cycle impact assessment and characterization factors (Annex II). Can provide a first estimate to help you understand the limitations and convenience of direct measurement approaches or more detailed modeling methods.
Detailed modeling methods	Developed for a specific context and are therefore more detailed and higher resolution. Typically build on scientific studies in a particular field. Specific bespoke modeling methods can be used on a case-by-case basis to supplement standardized modeling methods. Where limited data exist, databases can be used to model response to certain impact drivers.

Your choice of method should be appropriate to the level of rigor required for your accounting. When selecting your model and sources you should:

- Confirm that methods used consider local conditions to a suitable degree.
- Understand the limitations of methods used and check that they are suitable for your impact valuation purposes.

2.1.3 Value impacts (on society)

The Transparent methodology focuses on an approach to value the consequences of your natural capital impacts on society – the positive and negative contributions of business activities to human well-being in monetary terms. Users interested in conducting qualitative valuation will find some guidance in the Natural Capital Protocol.

Assessing the value of impacts on society requires an understanding of how changes in natural capital are linked to impact areas such as human health. This will be highly dependent on the impact driver and impact area under consideration. For example, the impact on society of reduced air quality will be far greater if it occurs close to densely populated areas, and the degree to which individuals contract diseases may also depend on their overall health. The degree to which people and nature are affected will be dependent on a range of factors, including local geography, population density, ecosystems, etc.

Moreover, there are different techniques to measure "value to society", and the choice of valuation method will significantly affect the results of your accounting. This section provides general rules – but more detail relevant to each of the impact drivers are found in sections 2.2.1-2.2.6.

To complete the valuation, you should quantify the effect that the change in natural capital has on human well-being and translate this into monetary terms. This involves the following actions:

- **Define the consequences of impacts and/or dependencies.** You will find the impacts of each impact driver included in the relevant section (2.2.1-2.2.6).
- **Select appropriate valuation technique(s) and undertake valuation.** In many cases, you will need to quantify impacts first in physical terms based on changes in natural capital, and then apply a method to value physical impacts in monetary terms. For other impacts, you will be able to apply monetary valuation directly without measuring impacts in physical terms. Again, you will find specifics in sections 2.2.1-2.2.6.

There are three main groups of valuation techniques[3] used to assess an impact on well-being in monetary terms, each leading to different results (see Box 3).

Box 3. Valuation techniques recommended in this methodology

1. **Market prices**
   This includes several related approaches:
   - Costs/prices paid for goods and services traded in markets, (e.g., timber, carbon, value of water bill or pollution permit).
   - Other internal/financial information, (e.g., estimated financial value of liabilities, assets, receivables).
   - Other interpretations of market data, (e.g., derived demand functions, opportunity costs, mitigation costs/aversive behavior, cost of illness).

[3] See also Natural Capital Protocol, p. 88 and 114 onwards

2. **Cost-based approaches**

   Replacement cost approach: The cost of replacing natural capital with an artificial substitute (product, infrastructure, or technology). May be estimated, observed, or modeled.

   Damage costs avoided: The potential costs of property, infrastructure, and production losses due to natural capital degradation, treated as a "saving" or benefit from conserving natural capital. May be estimated, observed, or modeled.

3. **Revealed preference approaches**

   Hedonic pricing: Based on the observation that environmental factors are one of the determinants of the market price of certain goods, (e.g., the environmental quality of a neighborhood affects the prices of properties located there). This technique models variations in market prices, controlling for other variables to isolate the environmental factor of interest. The extent to which price varies with this factor reveals its value.

4. **Stated preference approaches**

   Contingent valuation (CV): Infers ecosystem values by asking individuals their maximum willingness to pay (or willingness to accept compensation) for a specified change in the relevant non-market good or service from natural capital.

   Choice experiment (CE): Individuals are presented with alternative goods/options with different characteristics (i.e., various attributes or levels, such as distance, number of species present, or some other aspect of natural capital), as well as different prices. They are asked to choose their preferred option, from which the value for the relevant non-market good or service from natural capital may be inferred.

For each impact driver, you should use the valuation techniques indicated in the relevant detailed section of this document (sections 2.2.1-2.2.6). You may wish to apply different valuation techniques generating different sets of results (e.g., first set of results with damage cost, the second with revealed preferences) to provide complementary insights.

Note: You can find illustrative examples of the outputs resulting from measuring and valuing in Annex I.

The following three sub-sections provide guidance on specific topics to consider when valuing any of the impact drivers considered in this methodology:

a) Adjustments and value transfer
b) Valuing impacts on human health
c) Accounting for future impacts

a) Adjustments and value transfer

In practice, you may not be able to access valuation data that covers all possible situations (e.g., because a study with monetary valuation data refers to a specific country, ecosystem, time period, etc.). In this case, you can use value transfer. Value transfer consists of valuing an impact driver in one context based on valuation evidence (identified using one or more of the techniques discussed) determined in another context. Specific adjustments should be made to account for differences between the two contexts.

If you are taking data from other studies, you may need to adapt the values elicited in a study in a defined location and context to other locations and contexts (e.g., population exposed). This should be done using a transfer function controlling for all relevant variables, and which is dependent on the type of impact under consideration. The variables that you should control for are the contextual information defined in sections 2.2.1–2.2.6 of this document.

You should apply the following rules independent of the type of impact or impact driver:

- **Adjust for foreign exchange rates**: For impacts valued using different currencies, the exchange rate needs to match the time period defined in the scope of the study. Use data published by the World Bank, IMF or similar recognized institutions. Depending on the business application, it may be useful to use five-year rolling averages to avoid currency conversion artefacts.
- **Adjust for inflation**: When using data sets for valuation developed in the past, these should be adjusted to the time period considered in the scope of the study. You should use official sources of inflation such as the IMF and the World Bank.
- **Adjust for Purchasing Power Parity (PPP) (optional)**: You may adjust for purchasing power parity in your accounting, but in this case, you will need to communicate this adjustment clearly with the results of the study.

In any case, adjustments should be consistent across all impact drivers unless there are other provisions specified in the relevant impact driver section of this methodology. Deviations from this guidance should be justified.

b) Valuing impacts on human health

Often, the external impacts of environmental damage on individuals are negative physical and mental health outcomes. For this reason, valuing health impacts is common practice for most impact drivers. Valuing impacts on human health involves considering (premature) mortality as well as morbidity (disease). In general, monetary valuation of health impacts involves quantifying health impacts and then applying a suitable valuation approach.

Metrics to quantify health impacts

Different metrics can be used to quantify impacts on health. You should decide which metric is fit for purpose, taking into account the specific guidance for each impact driver. The options are:

- Number of cases
- A normalized metric, such as Disability-Adjusted Life Years (DALY) or years of life lost (YLL) (see Box 4). This is an attractive approach, but it is not always practical because of the ways in which health data are reported across the world.

Box 4. Normalized metrics of health

Some commonly used normalized metrics of health are:

Years of Life Lost (YLL)

As defined by the World Health Organization, years of life lost (YLL) is a measure of premature mortality that takes into account both the frequency of deaths and the age at which death occurs.

Disability-Adjusted Life Years (DALY)

A DALY is equivalent to one lost year of "healthy" life. The sum of DALYs across a population affected by different impact drivers, (e.g., air or water pollution) measures the gap between the health status with and without the occurrence of these impact drivers. DALYs for a disease or health condition are calculated as the sum of the years of life lost (YLL) due to premature mortality in the population and the years lost due to disability (YLD) for people living with the health condition or its consequences.

Assigning a value to premature mortality

The idea of associating a monetary value with human life is a challenging and contentious topic. Life is priceless, at least when considered from the complex perspective of an individual (OECD 2012). However, the value of life has been used by policymakers around the world when deciding whether regulations to reduce the likelihood of fatalities are worth the costs of implementing them. The need to inform policy decisions has led to a significant amount of research into an appropriate value to be used. To quantify the impact of changes in natural capital on society therefore requires an application of this research to estimate the value to society of negative externalities that lead to fatalities or increase the likelihood of fatalities.

Box 5 describes the different approaches to assess the value of impacts on (premature) mortality.

Box 5. Valuation approaches for mortality

- **Value of statistical life (VSL)** provides an aggregate of individuals' willingness to pay (WTP) for marginal reductions in their mortality risks. Value of statistical life estimates are typically based either on a stated preference or the revealed preference approach:
    - In the stated preference approach, individuals are presented with hypothetical options to reduce risk of mortality and asked to make choices (i.e., willing to pay for a new medical treatment).
    - In the revealed preference approach, individuals' behavior in actual markets is observed to estimate their willingness to pay for a reduction in their mortality risk (i.e., increased pay required to compensate employees for accepting jobs with a higher risk of death).

  Policymakers in different parts of the world make different choices on this. You should be consistent in your choice of VSL approach and document your source clearly.

- **Value per statistical life year (VSLY)** is the method for valuing in monetary terms premature mortality in the form of reduced life expectancy. There are few studies from which to derive a value for the VSLY. Annex III provides example of the existing sources.

  Note that there are further ways in which human life and mortality have an impact on society, but those are not covered by willingness to pay approaches, such as costs for healthcare systems, decreased productivity, etc.

Your choice of valuation approach will depend on the health impact metric used. Table 4 summarizes the valuation approaches that you should use depending on the health metric selected for assessing impact.

Table 4. Valuation approach for premature mortality to be used for each health metric

Health metric	Valuation approach
Number of cases	Value of statistical life (VSL)
Disability-Adjusted Life Years (DALY)	Value per statistical life year (VSLY)
Years of life lost (YLL)	

Valuing morbidity

Your choice of valuation approach will depend on the health impact metric used. Table 5 summarizes the valuation approaches that you should use depending on the health metric obtained in the impact assessment.

Table 5. Valuation approach for morbidity to be used for each health metric

Health metric	Valuation approach
Number of cases	Variable, depending on type of disease
Disability-Adjusted Life Years (DALY)	Value per statistical life year (VSLY)

c) Accounting for future impacts

Economic theory suggests that money and utility available now are valued more than money and utility available in the future.

When assessing impacts on society happening in the future, you should discount them. This can be done using the social discount rate to convert impacts into their present value, allowing a comparison between costs and benefits that happen in different moments of time. The **social discount rate** is a parameter that reflects the value for the society of future costs and benefits compared to the present ones.

The present value of future impacts should be estimated using the following formula:

$$PV = \sum_{t=0}^{n} \frac{V_t}{(1+r)^t} = \frac{V_0}{(1+r)^0} + \frac{V_1}{(1+r)^1} + \cdots + \frac{V_n}{(1+r)^n}$$

Where:

PV is the present value of an impact,
Vt is the value of an impact at year t,
r is the social discount rate,
n is the time horizon of the impact

When performing an accounting, treat future impacts consistently across all impact drivers (i.e., use consistent discount rates). See Annex III for more detail on the breakdown of the discount rate.

2.2 Specific rules by impact driver

Throughout sections 2.2.1-2.2.6 covering specific rules for each of the impact drivers, you should continue to apply the general rules discussed in section 2.1.

2.2.1 Measure your impact driver

2.2.1.1 Impact pathway and brief description

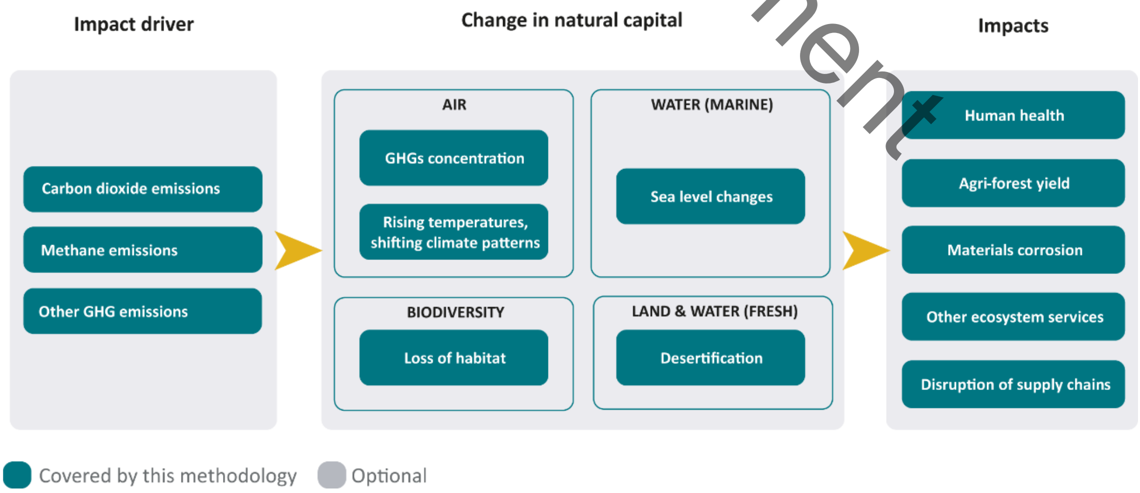
The earth's atmosphere shields us from harmful radiation, provides us with air to breathe and traps enough heat from the sun to enable the planet to support complex forms of life. Scientists have long been aware of this essential "greenhouse effect". However, in recent decades, they have become increasingly concerned about changes in the composition of the Earth's atmosphere and the potential of these changes to increase the amount of heat trapped.

The data now conclusively show that the Earth is warming and has been for some time. Scientists are confident that the net effect of human activities – and the resulting increase in atmospheric greenhouse gas (GHG) concentration – has contributed to this warming. This is discussed in detail by the Intergovernmental Panel on Climate Change (IPCC). Emissions of CO_2, other GHGs, aerosols, and ozone precursors affect the radiation absorption properties of the atmosphere. This has both short-term and long-term effects.

Even in the absence of humans, Earth has a naturally occurring carbon cycle in which carbon is exchanged between different living organisms and the environment through natural processes. Some processes (e.g., photosynthesis) remove GHGs from the atmosphere, while others (e.g., respiration or decomposition in the soil) emit carbon into the atmosphere. Since the industrial revolution, human activity has modified the carbon cycle by adding sources, (e.g., burning fossil fuels) and removing sinks (e.g., changes in land use, especially deforestation). This has led to an increasing concentration of GHGs in the atmosphere, which results in an increase in the greenhouse effect. This, in turn, changes the Earth's climate.

The steps of the impact pathway for GHG emissions are shown in Figure 4.

Figure 4. High-level impact pathway for GHG emissions



2.2.1.2 Measure your impact driver

Box 6 describes some key sources of GHG emissions that are relevant to natural capital accounting within a business context.

Box 6. Typical sources of GHG emissions

Any activity that disrupts the Earth's natural carbon cycle effectively changes the concentration of GHG emissions in the atmosphere.

Anthropogenic sources of (fossil) GHG emissions are mostly related to the burning of fuel, including in energy generation, transportation and heating. Other chemical or mechanical processes may also lead to the emission of GHGs.

Typical activities associated with GHG emissions include:

- Fuel burning in industry and power generation
- Fuel burning in transportation (air, sea, road)
- Chemical processes (this is often especially significant for non-CO_2 GHG emissions)

Whilst the local impacts of climate change may differ, it is the global concentration of GHGs in the atmosphere that drives climate change.

To measure your impact driver, you need to measure the mass of GHG emissions emitted to air. Table 6 presents the list of quantitative indicators for the main non-GHG pollutants that you should measure.

Table 6. Quantitative indicators to measure for GHG emissions

Tons of carbon dioxide (CO_2)
Tons of methane (CH_4)
Tons of N_2O
Tons of PFCs
Tons of HFCs
Tons of SF_6
Tons of NF_3
Optional: other (non-Kyoto) GHG

Since climate change is primarily driven by the global concentration of GHGs in the atmosphere, you do not need to collect further location- or context-specific information, unless this is useful to you for other purposes.

Not all GHGs contribute equally to climate change. Some, such as methane, have shorter lifetimes and contribute to near-term effects, whereas others, such as CO_2, have long lifetimes and contribute to longer-term effects. This is expressed in Global Warming Potential and Global Temperature change Potential (see Box 7).

Box 7. Global Warming Potential (GWP) and Global Temperature change Potential (GTP)

Greenhouse gases absorb energy and slow the rate at which energy escapes to space. The key ways in which gases differ from each other are their ability to absorb energy (their "radiative efficiency"), and how long they stay in the atmosphere (also known as their "lifetime").

The Global Warming Potential (GWP) was developed to allow comparisons of the global warming impacts of different gases. Specifically, it is a measure of how much energy the emission of one ton of a gas will absorb over a given period of time, relative to the emission of one ton of carbon dioxide (CO_2). The usual time period for GWPs is 100 years (GWP100).

An alternate metric is the Global Temperature change Potential (GTP). While the GWP is a measure of the heat absorbed over a given time period due to emission of a gas, the GTP is a measure of the temperature change at the end of that time period (also relative to CO_2). The calculation of GTP is more complicated than that of GWP, as it requires modeling how much the climate system responds to increased concentrations of GHGs (climate sensitivity) and how quickly the system responds (based in part on how the ocean absorbs heat).

UNEP recommends assessing short-term and long-term change separately, with GWP100 recommended for short-term impacts and GTP100 for long-term impacts.

2.2.1.3 Measure changes in the state of natural capital

The following actions are needed to complete this step:

- **Identify changes in capitals associated with your business activities and impact drivers.**
  The impact pathway of climate change is very broad and complex in that it involves multiple impacts of both regional and global nature and extends from the shorter term into the more distant future. Changes to natural capital arise from the increased concentration of GHGs in the atmosphere and include rising mean temperatures, shifting climate patterns, sea level changes, desertification, as well as loss of habitat, which may lead to movement of species. The effect of GHG emissions depends primarily on their lifetime in the atmosphere (see Box 7).

  As a default (minimum) requirement, this methodology requires you to assess global impacts for a reference period of 100 years based on Global Warming Potential (rather than Global Temperature Potential).

  Depending on your business application, you may also be interested in local effects. These are likely to be more relevant when investigating impacts on business and dependencies, rather than impacts on society.

- **Measuring change.** You will not need to measure each of these categories of changes to natural capital directly, as this is implicitly covered in the Global Warming Potential as well as the valuation approach (social cost of carbon, see Box 8). For this step you will convert the effect of other GHG emissions to that of CO_2 equivalents using the Global Warming Potential GWP100, following indications in Table 7. Ensure that you use the most recent scientific evidence from the Intergovernmental Panel on Climate Change for the Global Warming Potential (GWP).

Table 7. How to measure changes in natural capital from GHG emissions

Indicator (impact driver)	**How to measure change in natural capital**
GHG emissions (CO_2, CH_4, N_2O, PFCs, HFCs, SF_6, NF_3 and optionally, other (non-Kyoto) GHG C)	You do not need to measure changes in natural capital directly, as these are implicit in climate models. • Short-term: Global Warming Potential with a reference period of 100 years (GWP 100), based on most recent scientific evidence from the Intergovernmental Panel on Climate Change (IPCC). Optional: other reference periods • Long-term (optional): Global Temperature change Potential (GTP).

2.2.1.4 Value impacts

Complete the following actions to value the consequences of your impacts on society:

- **Define the consequences of impacts and/or dependencies.**
  Impacts on society include impacts to human health (e.g., due to heat stress, malnutrition), agri-forest yield, materials corrosion, disruption of provision of ecosystem services (resulting in, for example, disruption of supply chains), etc. Given the interdependencies between different impacts, it is not typically possible (or useful) to single out individual impacts on society in an accounting.

- **Select appropriate valuation technique(s) and undertake valuation**
  To assess the impact on society you should use a model that reflects the complexities of climate science and does not single out individual impacts. You should specify which model has been selected. See also IPCC 2013 regarding climate models.
  For monetary valuation of impact on society, use a global social cost of carbon (SCC) and apply this to your GHG emissions in CO_2 equivalents (see Box 8). Always document your key assumptions (particularly around ethical choices), as well as the source.

Box 8. Social cost of carbon

The social cost of carbon (SCC) is an estimate, in monetary terms, of the economic damages that would result from emitting one additional ton of carbon dioxide into the atmosphere. It is widely used by policy makers and other decision makers to understand the economic impacts of decisions that would increase or decrease GHG emissions.

The SCC is calculated in four steps using specialized computer models:

1. Predict future emissions based on population, economic growth and other factors.
2. Model future climate responses, such as temperature increases and sea level changes.
3. Assess the economic impact of these climatic changes on agriculture, health, energy use and other aspects of the economy.
4. Convert future damages into their present-day values and sum to determine total damages.

These four steps provide a baseline value for the damages caused by emissions. The modeling process is then repeated after including a small amount of additional emissions to determine the impact on the total cost of emission-related damages. The increase in damages from the additional emissions provides an estimate of the SCC.

It should be noted that not all policy makers use the same SCC. Variations arise from modeling choices that in part reflect ethical choices, particularly around equity and how to value the cost to future generations.

2.2.2 Non-GHG emissions

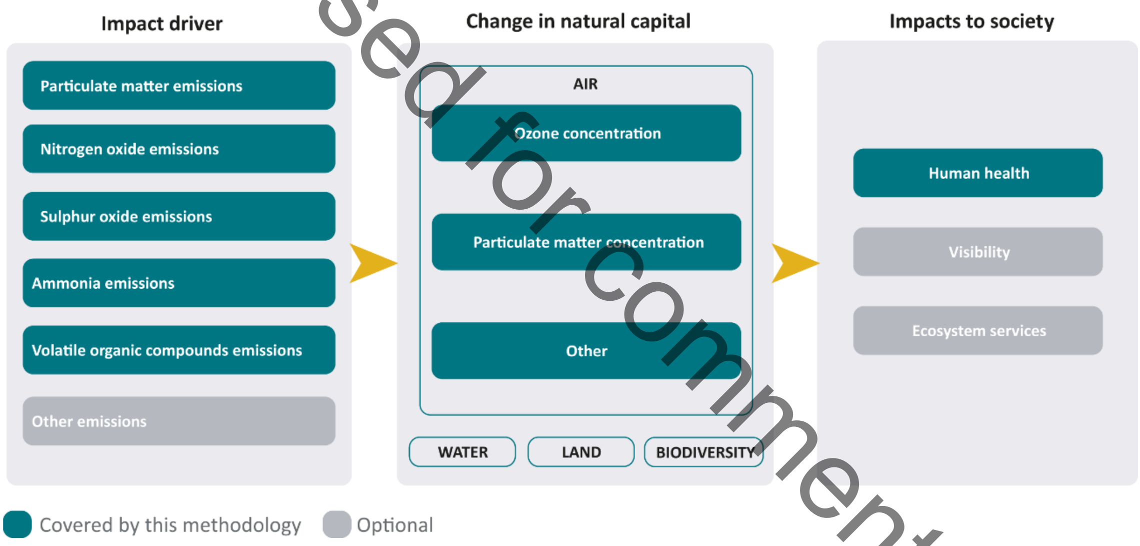
2.2.2.1 Impact pathway and brief description

Release into the air of non-GHG air emissions changes the concentration of pollutants and hence ambient air quality, which affects human health (e.g., contributing to respiratory infections and heart disease), biodiversity and the extent and condition of habitats. This in turn can lead to further impacts on society, for example through changes in agriculture and associated loss in productivity.

Unlike greenhouse gas emissions, which contribute to climate change on a global scale, the impacts of air pollution are principally local or regional. Local or regional factors, such as weather conditions and population density, influence the magnitude and severity of impacts from air pollutants. Non-GHG air pollutants can be subdivided into "primary pollutants", which directly cause negative impacts, and "secondary pollutants", which originate from the reaction between primary pollutants and other gases in the atmosphere under certain conditions, and which subsequently also have negative impacts.

The impact pathway for non-GHG air pollutants is shown in Figure 5.

Figure 5. High-level impact pathway for non-GHG emissions



The Transparency methodology provides standardized approaches for assessing and valuing the impacts shown in this impact pathway. Other pollutants and impacts linked to air quality, beyond those presented here, may be covered with similar approaches.

2.2.2.2 Measure your impact driver

Box 9 describes some key sources especially relevant to non-GHG air emissions that you should consider.

Box 9. Typical sources and activities related to non-GHG air emissions

There are both natural and anthropogenic sources of air pollutants. Anthropogenic sources are mostly related to the burning of fuel, including in energy generation, transportation and heating. Other chemical or mechanical processes may also lead to the emission of pollutants. Typical activities associated with non-GHG air emissions include:

- Industrial fuel burning
- Private use of fuel, such as in household cookstoves
- Deforestation and land use change
- Agriculture, in particular the use of fertilizers
- Transportation (air, sea, road)

Mobile sources generally disperse differently than stationary sources. Therefore, the impact associated with air pollutants depends not just on the type of pollutant but also the type of source. This point is not always covered by available models.

To measure your impact driver, you need to measure the mass of non-GHG emissions released to air. Table 8 presents the list of quantitative indicators for the main non-GHG pollutants that you should measure.

Table 8. Quantitative indicators to measure for non-GHG emissions

Tons of fine particulate matter ($PM_{2.5}$)
Tons of coarse particulate matter (PM_{10}) [optional]
Tons of nitrogen oxides (NO_2, NO and NO_3)
Tons of volatile organic compounds (VOC or NMVOC)
Tons of sulphur oxides (SO_2, SO, SO_3, SO_X)
Tons of ammonia (NH_3)

To perform the next steps, you will need to collect further information on the context of the emission sources (location, neighboring population density, altitude of emissions, moving or stationary source, etc.). Box 10 provides further considerations on models, service providers and sub-indicators.

Box 10. Models, service providers and sub-indicators

Natural capital accounting is most accurate when changes in natural capital can be measured directly. This is often not possible or feasible. However, based on scientific research typical (empirical) patterns can be reflected in data models. Various service providers have developed models that define a specific context and sub-indicators for impact drivers, which are sometimes called "emission compartments".

If working with an external data provider, your choice of model should be based on the considerations for selecting (secondary) data sources discussed in section 2.1.1.

2.2.2.3 Measure changes in the state of natural capital

Implementing models to reflect changes in natural capital, as well as impacts on society and business arising from these changes, takes expert knowledge and you are very likely to need external support for this. It is likely that you will not perform the following actions directly yourself.

The following actions are needed to complete this step:

- **Identify changes in capitals associated with your business activities and impact drivers.** You need to measure changes in air quality resulting from your non-GHG emissions. Table 9 presents the list of changes in air quality that should be assessed.

Table 9. Changes in natural capital to measure for non-GHG emissions

Indicator (impact driver)	Change in natural capital
Tons of particulate matter ($PM_{2.5}$)	• Change in fine particulate matter concentration
Tons of particulate matter (PM_{10})	• Change in coarse particulate matter concentration
Tons of sulphur dioxide (SO_2)	• Formation of sulphates SO4-, contributing to change in fine particulate matter concentration (secondary $PM_{2.5}$)
Tons of ammonia (NH_3)	• Formation of ammonium NH4+, contributing to change in fine particulate matter concentration (secondary $PM_{2.5}$)
Tons of mono-nitrogen oxides (NO, NO_2, NO_x)	• Formation of NO3-, contributing to change in fine particulate matter concentration (secondary $PM_{2.5}$) • Formation of ozone O_3, leading to increasing ozone concentration
Volatile organic compounds (VOCs)	• Formation of ozone O_3, leading to increasing ozone concentration

- **Measuring change.** To complete this action, you should use a modeling approach**.** This can be done using:
    i. a bespoke air dispersion model that accounts for local meteorological conditions and type of emission source (e.g., stationary/mobile, high/low altitude), or
    ii. pre-existing models, such as from life cycle inventories or similar data sources that provide characterization factors for a set of predefined contexts. Pre-existing models may either be based on dispersion models (good practice) or use proxies to characterize different contexts.

2.2.2.4 Value impacts

Complete the following actions to value the consequences of your impacts on society:

- **Define the consequences of impacts and/or dependencies.** You should include the impacts outlined in Table 10.

Table 10. Impacts of non-GHG emissions to assess

Human health
Visibility (optional)
Provisioning ecosystem services (e.g., agriculture and/or forest production) (optional)

- **Select appropriate valuation technique(s) and undertake valuation**

You should first quantify impacts in physical terms, based on changes in natural capital. Then select a method to value your impacts in monetary terms.

  - To perform quantitative valuation (in physical terms), select and apply one of the quantitative valuation techniques outlined in Table 11, for each of the impacts assessed.

Table 11. Quantitative valuation techniques to use for non-GHG emissions

Impact category	Quantitative valuation technique
Human health	Dose-response functions. These types of functions account for the reaction of a population or asset (such as crops, forests, buildings, etc.) to exposure to pollution in the atmosphere. Characterization factors from life cycle assessment implicitly use dose-response functions so can also be used, as far as the level of granularity is fit for purpose.
Visibility (optional)	Function transfer
Ecosystem services lost (optional)	Dose-response functions

  - Monetary valuation: Once you have completed the quantitative valuation, select and apply one of the monetary valuation techniques outlined in Table 12 for each of the impacts assessed.

Table 12. Techniques for monetary valuation of impacts for non-GHG air emissions

Impact category	Monetary valuation technique
Human health	Stated or revealed preference approaches
Visibility (optional)	Contingent valuation
Ecosystem services lost (optional)	Market prices

2.2.3 Water consumption

2.2.3.1 Impact pathway and brief description

Water and in particular fresh water, plays a central role in ecosystems: without water, almost no life on earth could survive. Clean water is an essential resource for human health, agriculture, energy production, transport and nature. There is significant global concern regarding the state of water resources, which are subject to significant pressure from increasing water demand, with pressures projected to be exacerbated by climate change.

Water depletion affects humans and ecosystems. The impact of water depletion on humans depends on the local demand structure (domestic, industrial and agricultural, as well as environmental). Where water becomes scarce, this can directly impact productivity, with the availability of water limiting economic activity – particularly in agriculture and industry. Water scarcity also often leads to compensation processes: where domestic access to water is limited, people might resort to lower-quality water sources, leading to sanitation and hygiene issues (water access, sanitation and hygiene, WASH), which can have an impact on human health. Water scarcity may also lead communities to invest in (costly) water supply infrastructure such as water treatment or desalination plants, which may drive up the cost of supply.

Additionally, unmet water demand within ecosystems can lead to a loss of habitat, with further impacts on biodiversity, loss of ecosystem services, etc.

Box 11 explains the difference between water consumption, water use and water scarcity.

Box 11. Water consumption, water use and water scarcity

It is important to distinguish between water use (or withdrawal) and water consumption.

WRI (2013) defines the two measures as follows:

Water use "describes the total amount of water withdrawn from its source to be used. Measures of water usage help evaluate the level of demand from industrial, agricultural, and domestic users."

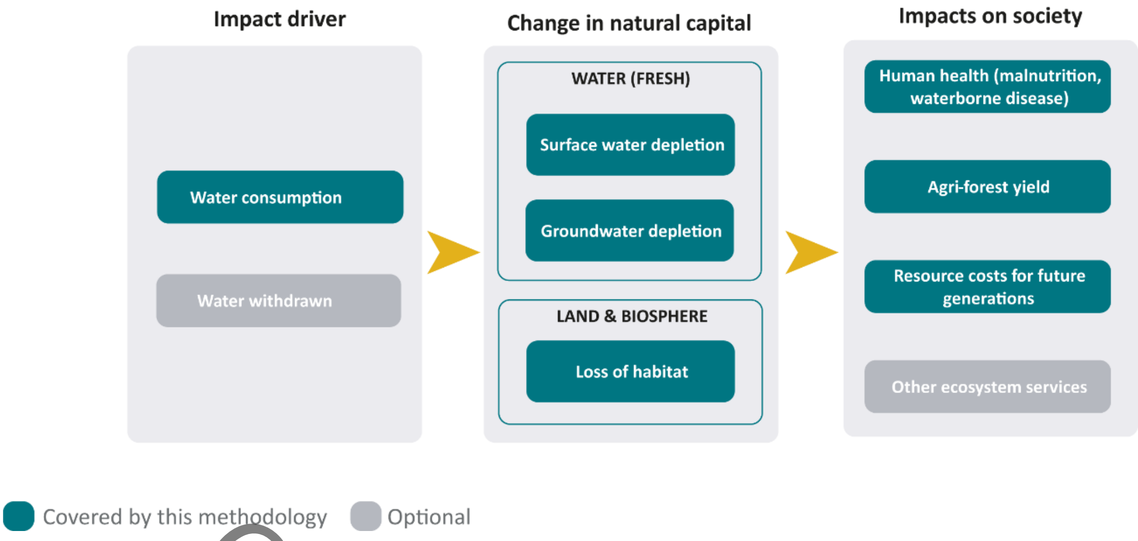
Water consumption "is the portion of water use that is not returned to the original water source after being withdrawn. Consumption occurs when water is lost into the atmosphere through evaporation or incorporated into a product or plant (such as a corn stalk) and is no longer available for reuse."

Depleting water from a system generally leads to water scarcity, which is the lack of available water to meet demand, where demand can be both from humans and the natural environment.

Section 2.2.3 addresses the impact of water consumption. Impacts associated with discharge (and pollutants) are addressed in section 2.2.4

The steps of the impact pathway for water consumption are shown in Figure 6.

Figure 6: High-level impact pathway for water consumption



2.2.3.2 Measure your impact driver

To measure your impact driver, you need to measure the volume of water consumption. Table 13 presents the list of quantitative indicators that you should measure.

Table 13. Quantitative indicators to measure for water consumption

Volume (m^3) of water consumption
Optional: volume of water withdrawn

The extent to which water use contributes to water stress or scarcity may vary by location and seasonally. To complete the next steps, you should collect additional information on context, including geography, season/time of year, information on scarcity or other demands.

The degree of regional specificity should be in line with your accounting goals. For a (rough) hotspot analysis, country-level averages of water stress may be sufficient. If you are active in areas that you know are water scarce, watershed or sub-watershed detail may be appropriate.

Box 12 provides hints on estimating water consumption.

Box 12. Hints on estimating water consumption

To measure the water consumed, it may be helpful to create a water balance by measuring the water withdrawal (input) and subtracting the water released (output). Your water balance should include types of withdrawal per source (e.g., groundwater, river, municipal water supply), especially if the water is released back to a different watershed.

Beyond the sources mentioned in the section 2.1.1, secondary data specifically for water are available from national statistics databases, the Water Footprint Network (WFN) or the MIT Shift Capital Toolkit, and other sources.[4]

When using secondary data sources, you should consider that they may provide data on only water withdrawal. Water consumption can be derived from withdrawal using standard consumption rates from literature. These consumption rates can vary significantly even within

[4] The MIT Shift Capital Toolkit

the same sector, as they depend on technology use, local climate and other parameters. For example, water consumption rates associated with irrigation can vary from 20% to 80% depending on the type of technology (sprinkler, flooding, drip, etc.) and climate (tropical, temperate, etc.).

2.2.3.3 Measure changes in the state of natural capital

Implementing models to reflect changes in natural capital, as well as impacts on society and business arising from these changes, takes expert knowledge and you are very likely to need external support for this. It is likely that you will not perform the following actions directly yourself.

The following actions are needed to complete this step:

- **Identify changes in capitals associated with your business activities and impact drivers.** You need to measure changes in water availability resulting from your water consumption. Table 14 presents the list of changes in natural capital that should be assessed.

Table 14. Changes in natural capital to measure for water consumption

Indicator (impact driver)	Change in natural capital
Water consumption	• Surface water depletion • Groundwater depletion • Loss of habitat

- **Measuring change.** To complete this action, you should use a modeling approach**.** This can be done using: (i) bespoke hydrological models to assess the changes in natural capital resulting from water consumption and accounting for local environmental conditions. (ii) pre-existing models, such as from life cycle inventories or similar data sources that provide characterization factors for a set of predefined contexts. Pre-existing models may either be based on hydrological models (good practice) or use proxies to characterize different contexts. Contextual information should be taken into account to measure change. Box 13 provides some considerations regarding contextual information to be considered.

Box 13. Contextual information on water consumption

Water scarcity depends both on the supply or rate of regeneration of water, and on the demand from all user groups. Depending on the local context, there may be significant variations in seasonal water availability.

Depleting water from a given water body will reduce the availability to other water users (including ecosystems), whose needs may no longer be met. In general, the less water remains, the more other users will be deprived. This includes both human and environmental demand, and may reduce the functioning of ecosystems, especially in riparian areas. Water scarcity is not just a question of natural capital extent however: depleting groundwater at an unsustainable rate may also lead to inflow of saline water, also affecting the quality of natural capital.

Water stress or scarcity is highly dependent on the specific context, including the local hydrology situation, human activities, climatic conditions / seasonal variations in precipitation, as well as the state of the local environment. Sources of data and pre-existing models include AQUASTAT, AWARE (Available WAter REmaining) and WSI (Water Scarcity Index) or the MIT Shift Capital Toolkit, among others.[5]

[5] The MIT Shift Capital Toolkit

2.2.3.4 Value impacts

Complete the following actions to value the consequences of your impacts on society:

- **Define the consequences of impacts and/or dependencies.** Include the impacts outlined in Table 15.

Table 15. Impacts of water scarcity to assess

Human health (malnutrition, waterborne diseases)
Agri-forest yield
Resource costs for future generations
Other ecosystem services (optional)

- **Select appropriate valuation technique(s) and undertake valuation**
  You should first quantify impacts in physical terms, based on changes in natural capital. Next, select a method to value your impacts in monetary terms.
  - To perform quantitative valuation (in physical terms), select and apply one of the quantitative valuation techniques outlined in Table 16, for each of the impacts assessed.

Table 16. Quantitative valuation techniques to use for water consumption

Impact category	**Quantitative valuation technique**
Human health	The linkage between water scarcity and human health depends on the incapacity to adapt economically, leading to a lack of water for domestic users, the use of alternative (lower quality) water supply and the spread of waterborne diseases. This impact is less likely to occur in countries with higher socioeconomic development levels, as they typically have better water management practices in place. It is recommended that you estimate impacts on human health via a measure of water stress and DALYs (per cubic meters) To estimate impacts in terms of DALYs, you can either use characterization factors from life cycle assessment models, or econometric data, as far as the level of granularity is fit for purpose.
Various economic costs: replacement costs, economic opportunity costs subsidy costs	(Recommended to be expressed directly in monetary terms) Replacement costs: Some communities are dependent on groundwater and are extracting it at an unsustainable rate leading to groundwater depletion and an inflow of saline water. Overexploitation of non-renewable water supplies will lead to future impacts associated with the increased scarcity and cost of supply, unless replacement sources are secured. Economic opportunity costs: Where there is direct competition for water, and the corporate entity using the water is not the most economically productive user (based on the marginal private and public benefits of production), there is an opportunity cost of water use. Subsidy cost of water: Water pricing rarely reflects the financial cost of water supply and is frequently subsidized. Corporate entities use therefore increases the financial burden for taxpayers.
Provisioning ecosystem services (i.e., agriculture and/or forest production) (optional)	(To follow -> Align project)

- Monetary valuation: Once you have completed the quantitative valuation, select and apply one of the monetary valuation techniques outlined in Table 17, for each of the impacts assessed.

Table 17. Monetary valuation techniques to use for water consumption

Impact category	Monetary valuation technique
Human health	Stated or revealed preference approaches
Replacement costs	Market prices for cost of supply: desalination costs, transport costs
Economic opportunity costs	Cost-based: marginal productivity of consumption. Estimate the loss in benefits (including private revenues and public gains) as a result of inefficient allocation of water resources, based on the marginal productivity of consumption
Subsidy costs	Market prices, cost of water supply
Provisioning ecosystem services (i.e., agriculture and/or forest production) (optional)	Damage cost

2.2.4 Water pollution

2.2.4.1 Impact pathway and brief description

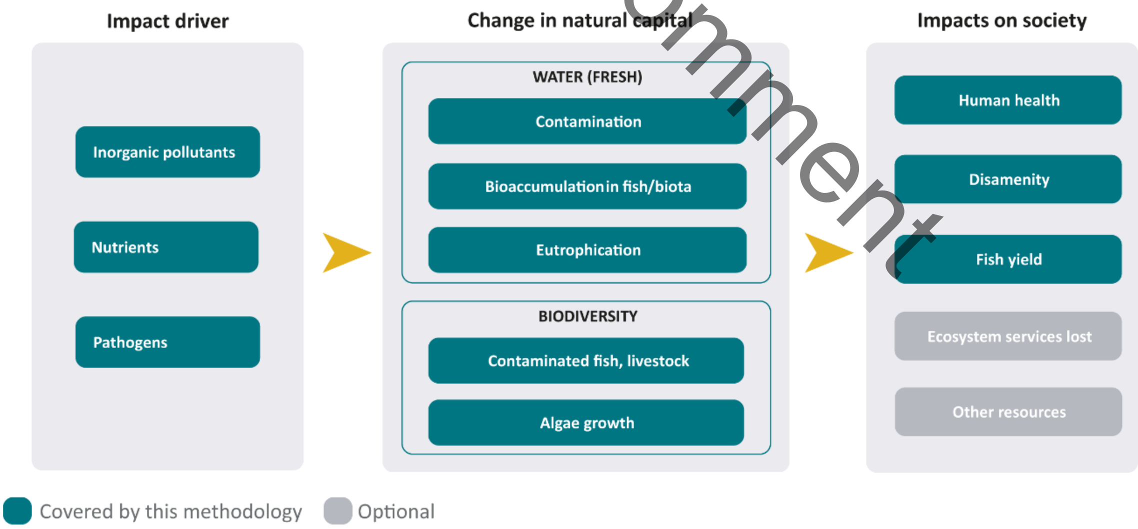
Water, and in particular fresh water, plays a central role in ecosystems: without water, almost no life on earth could survive. Clean water is an essential resource for human health, agriculture, energy production, transport and nature. But there is significant global concern for the state of water resources, as human discharge of substances into water affects the quality of water bodies.

The most significant water-pollutant categories (in terms of societal cost) are:

- **Inorganic pollutants**: Inorganic toxic substances, including heavy metals and chemical compounds that may persist or cause undesirable changes in the natural environment, bioaccumulate in the food web and have adverse effects on human health.
- **Nutrient pollutants**: Nitrogen (N) and phosphorus (P) are basic building blocks of plant and animal proteins. In elevated concentrations, they can cause a range of negative effects, such as algal blooms that lead to a lack of oxygen in the water.
- **Pathogens**: Coliforms are a broad class of bacteria, some of which are harmful, disease-causing organisms, such as *Escherichia coli* (*E. coli*). These can be released or encouraged to grow through discharges of inadequately treated sewage.
- **Thermal pollution**: Discharges of water above or below the ambient temperature of natural water bodies can change the ecological balance.
- Despite improvements in some developed countries, water pollution is on the rise globally. Pollution and the degradation of water bodies can adversely affect human well-being and, thereby, carry a societal cost.

The steps of the impact pathway for water consumption are shown in Figure 7.

Figure 7. High-level impact pathway for water pollution



2.2.4.2 Measure your impact driver

To measure your impact driver, you need to measure the mass of pollutants released to water. Table 18 presents the list of quantitative indicators for the main effluents that you should measure.

Table 18. Quantitative indicators to measure for water pollution

Mass of nutrients: Nitrogen (N) and phosphorus (P) (kg)
Mass of pathogens (kg) (optional)
Mass of inorganic pollutants: heavy metals, chemical compounds (kg)

To perform the next steps, you will need to collect further information on the context of the pollutants and the waterways into which they are released (especially location, existence of wastewater treatment, etc.). See Box 14 for further information on this.

Box 14. Hints on measuring indicators for water pollution

To measure water pollution, effluent discharges from in-line measurement are the most accurate data. However, aside from large, regulated facilities in developed countries, this is rarely a practical approach. As an alternative, the drivers of water pollution can be measured to indirectly estimate discharges. For example, the quantity and type of chromium together with specifics on the tanning process can be used to calculate the load and toxicity of the discharges that result from the tanning of a hide. Similarly, typical loading factors can be used for phosphorous runoff associated with pastoral agriculture.

When using (standard) life cycle inventory data sets, you should always consider whether these include wastewater treatment as a separate process step.

2.2.4.3 Measure changes in the state of natural capital

Implementing models to reflect changes in natural capital, as well as impacts on society and business arising from these changes, takes expert knowledge and you are very likely to need external support for this. It is likely that you will not perform the following actions directly yourself.

The following actions are needed to complete this step:

- **Identify changes in capitals associated with your business activities and impact drivers.** You need to measure changes in water quality as well as secondary effects resulting from your effluents. Table 19 presents the list of changes to natural capital that should be assessed.

Table 19. Changes in natural capital to measure for water pollution

Indicator (impact driver)	Change in natural capital
Nutrients	• Algae growth • Bioaccumulation in fish/biota • Eutrophication
Inorganic pollutants	• Contamination, leading to change in water quality • Contaminated fish/livestock through bioaccumulation

- **Measuring change.** To measure change you should use a modeling approach**.** This can be done using: (i) a bespoke hydrological dispersion model that accounts for specific local conditions or (ii) pre-existing models, such as from life cycle inventories or similar data sources that provide characterization factors for a set of predefined contexts. Pre-existing models may either be based on dispersion models, chemical fate and exposure functions (good practice) or use proxies to characterize different contexts.

2.2.4.4 Value impacts

Complete the following actions to value the consequences of your impacts on society:

- **Define the consequences of impacts and/or dependencies.** You should include the impacts outlined in Table 20.

Table 20. Impacts of water pollution to assess **for water pollution**

Human health
Change in property value
Changes in fish yield
Provisioning ecosystem services (i.e., agriculture and/or forest production) (optional)
Other resources

- **Select appropriate valuation technique(s) and undertake valuation**
  You should first quantify impacts in physical terms, based on changes in natural capital. Next select a method to value your impacts in monetary terms.

  - To perform quantitative valuation (in physical terms), select and apply one of the quantitative valuation techniques outlined in Table 21 for each of the impacts assessed.

Table 21. Quantitative valuation techniques to use for water pollution

Impact category	Quantitative valuation technique
Human health	Dose-response functions. These types of functions quantify the likelihood of reaction of a population or asset (such as crops, forests, buildings, etc.) resulting from exposure to a certain level of pollution in water. Characterization factors from life cycle assessment implicitly use these functions so can also be used, as far as the level of granularity is fit for purpose.
Disamenity: Changes in property value, Loss of recreation	Fate factors, which describe the persistence of a contaminant in air, water and soil. They are based on a substance's mobility and persistence in the environment.
Changes in fish yield	Bioaccumulation factors, the ratio of the chemical concentration in fish to the chemical concentration in the water body where the fish are exposed
Ecosystem services lost (optional)	Fate factors

  - Monetary valuation: Once you have completed the quantitative valuation, select and apply one of the monetary valuation techniques outlined in Table 22 for each of the impacts assessed.

Table 22. Monetary valuation techniques to use for water pollution

Impact category	Monetary valuation technique
Human health	Stated or revealed preference approaches
Disamenity	Stated or revealed preference approaches
Ecosystem services lost (optional)	(To follow -> Align)

2.2.5 Land use

2.2.5.1 Impact pathway and brief description

Important note: Transparent's sister project, "Align", is developing a standardized approach to accounting specifically for biodiversity, to complement Transparent and to be integrated in this methodology. This draft has been developed prior to the delivery of the "Align" project outputs. Given the close links between land use and biodiversity, this section will be revised once Align outputs are developed (before the end of the Transparent Project).

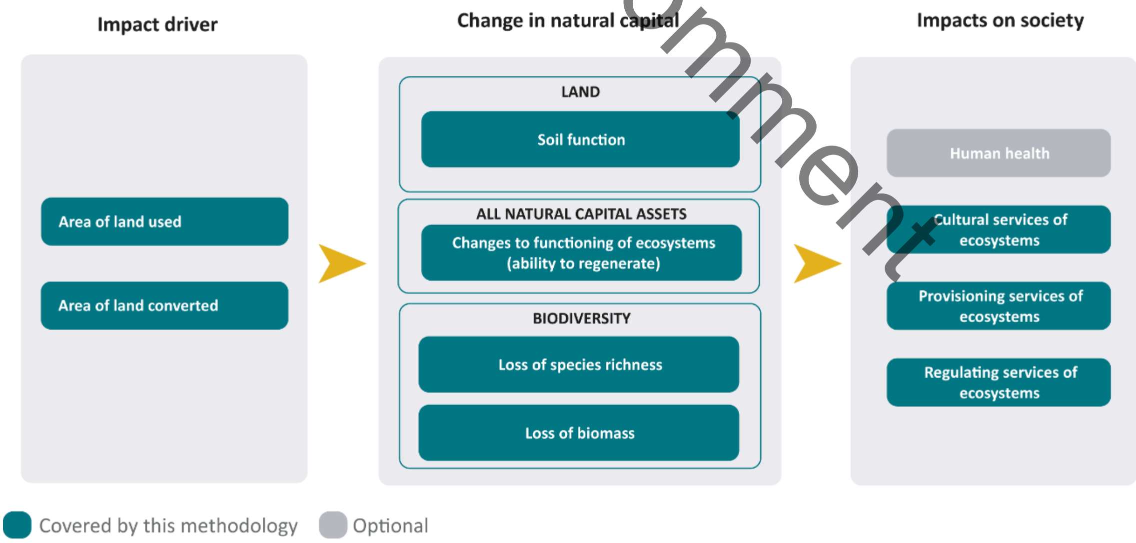
Land use refers to human intervention or management of a given area. It includes both activities undertaken, and the institutional arrangements put in place (SEEA 2012). Land use and land use change are some of the main drivers of biodiversity loss and degradation of a broad range of ecosystem services (MEA 2005). This includes the degradation of soil quality which further affects ecosystem services (UNEP 2017).

The value of land to society is largely determined based on the type of land and the ecosystems it supports. This is described in terms of land cover, the physical and biological material covering the Earth's surface including natural vegetation and abiotic (non-living) surface.

Ecosystems have the ability to regenerate, and the biosphere's regeneration is key to long-term sustainability. The natural processes underlying this regeneration are complex and still not understood well (Dasgupta 2021), some aspects of natural processes and their values cannot be captured with monetary techniques. The methodology included here is aimed at valuing impacts in monetary terms. Consequently, the methodology included here should be supported by qualitative analysis to have a complete understanding of all aspects of the natural processes.

The steps of the impact pathway for land use are shown in Figure 8

Figure 8. High-level impact pathway for land use



2.2.5.2 Measure your impact driver

To measure your impact driver, you need to measure the area of land used and area of land converted. Table 23 presents the list of quantitative indicators for the main land cover types you should measure.

Table 23. Quantitative indicators to measure for land use

Area of land used (ha) is the area of land occupied by activities driven by business, (e.g., used for agriculture or other raw materials or for living/working space). Use of an area implies the existence of some human intervention or management. As a result, land used is not in its pristine state but will have been previously converted.
Area of land converted (ha) is the area of land where land cover (the observed physical and biological cover of the Earth's surface including natural vegetation and abiotic (non-living) surfaces) is changed through activities driven by business.

To perform the next steps, you will need to collect further information on the context and the type of land used (especially location, type of land cover/ecosystem, etc.). See Box 15 for further information on this.

Box 15. Hints on measuring indicators for land use

Unless you are using land directly in your own operations, it is likely that you will need to estimate the land use entailed by your business activities. You will also likely have to work with assumptions regarding the locations and ecoregions associated with your business activities.

Certain materials / crops are typically produced in specific locations; you should use trade statistics to determine the likely location of origin if you lack specific information.

2.2.5.3 Measure changes in the state of natural capital

The following actions are needed to complete this step:

- **Identify changes in capitals associated with your business activities and impact drivers.** You need to measure changes in the extent and quality of different types of land cover, as well as the associated ecosystem function. Table 24 presents the list of changes to natural capital that should be assessed.

Table 24. Changes to natural capital to measure for land cover

Indicator (impact driver)	Change in natural capital
Land converted	Ecosystems are a dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit. Converting land cover can affect all aspects of this, leading to changes notably including: • Change in soil quality (soil organic carbon) • Changes to functioning of ecosystems (ability to regenerate) • Change in species richness • Change in biomass Your measurement of changes should use the pristine state as a baseline.
Land use	Land that is occupied today is no longer in its pristine state, and was therefore converted from this state at some time in the past (see definition in table 22 on impact drivers). Consequently, your measurement of changes should use the pristine state as a baseline.

- **Measuring change.** To complete this action, you should use a modeling approach**.** It should be noted that, at the time of writing, there is no single model available that covers all aspects of land use. Given the complexity of flows and stocks related to land use and land use change, it is unlikely that you will be able to create a fully bespoke model. You should use a modeling approach that defines ecoregions with distinct biomass quantities, species, and soil organic carbon. You may use available models defining typical ecological and environmental conditions (e.g., tropical rainforest, temperate grasslands, etc.) as a proxy.

2.2.5.4 Value impacts

Complete the following actions to value the consequences of your impacts on society:

- **Define the consequences of impacts and/or dependencies.** Ecosystem services are the contributions provided by ecosystems of benefits used in economic and other human activity. Degradation of ecosystems may affect the capacity to generate services both in terms of their quality and quantity. You should include the impacts outlined in Table 25.

Table 25. Impacts of land use

Regulating services of ecosystems (e.g., provided by forests when they act as a sink for carbon)
Provisioning services of ecosystems (e.g., the provision of timber from forests)
Cultural services (e.g., enjoyment provided to visitors to a national park)
Human health (optional)

- **Select appropriate valuation technique(s) and undertake valuation**
  In the case of services provided by ecosystems, you should quantify impacts directly in monetary terms, without the need for a quantitative physical impact metric. For human health, you should first quantify impacts in physical terms, based on changes in natural capital. Then you should select a method to value your impacts in monetary terms.

  - To perform quantitative valuation (in physical terms) you should select and apply one of the quantitative valuation techniques outlined in Table 26, for each of the impacts assessed.

Table 26. Quantitative valuation techniques to use for land use

Impact category	Quantitative valuation technique
Regulating services of ecosystems	In this case, it is recommended that impacts are valued directly in monetary terms without the need for a quantitative physical impact metric.
Provisioning services of ecosystems	In this case, it is recommended that impacts are valued directly in monetary terms without the need for a quantitative physical impact metric.
Cultural services	In this case, it is recommended that impacts are valued directly in monetary terms without the need for a quantitative physical impact metric.
Human health (optional)	Dose-response functions

- Monetary valuation: Once you have completed the quantitative valuation, select and apply one of the monetary valuation techniques outlined in Table 27, for each of the impacts assessed.

- An important consideration regarding land use is the temporal dimension. Many natural areas were converted long ago and have changed uses and ownership many times since. Ecosystem services are flows, such that if their provision is reduced, that reduction is felt every year until the land is restored. You should account for ecosystem service reduction in the current year relative to the natural state and assign this reduction in value to the current occupant of the land, irrespective of whether that occupant was directly responsible for the land's conversion. For this reason, you should use marginal values.

Table 27. Monetary valuation techniques to use for land use

Impact category	Monetary valuation technique
Regulating services of ecosystems	Contingent valuation
Provisioning services of ecosystems	Contingent valuation
Cultural services	Contingent valuation
Human health	Stated or revealed preference approaches

2.2.6 Waste

2.2.6.1 Impact pathway and brief description

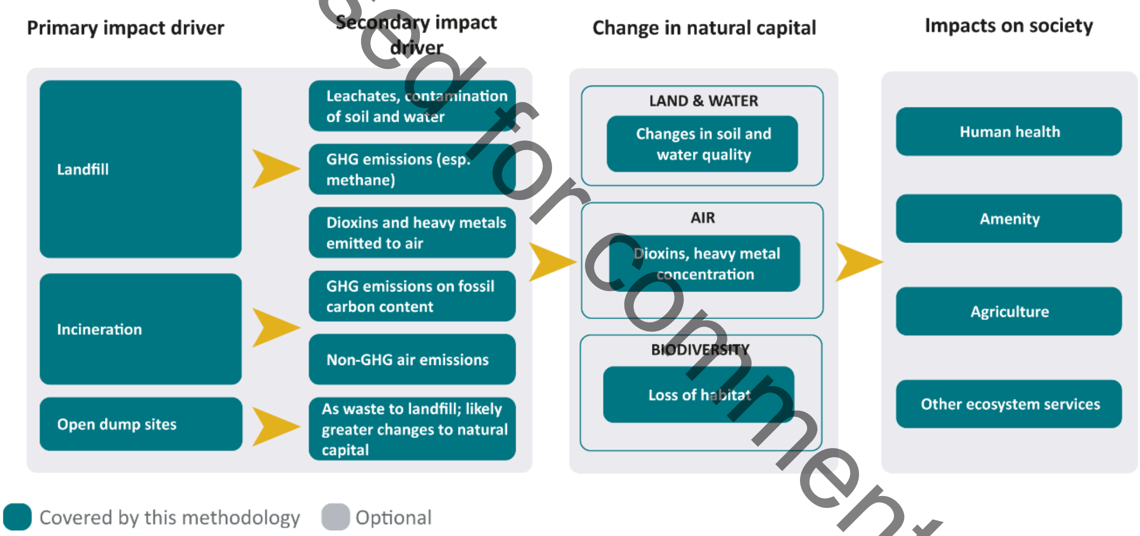
Corporate activities in all sectors generate solid waste. The disposal of this solid waste can lead to a range of changes to natural capital that adversely affect human well-being, thereby carrying a cost to society. This section is concerned with the impacts of waste disposal. It does not evaluate the costs associated with design or production inefficiencies that may be indicated by the presence of waste.

For solid-waste disposal, the type of waste (e.g., hazardous, non-hazardous) and the method of its disposal (incineration, landfill, non-managed dump sites, recycling) are key factors that dictate how natural capital is affected as well as the type and magnitude of impacts.

Given that recycling essentially closes the loop and provides raw materials, associated processing is not covered further here but should be included in mapping the value chain more generally.

The steps of the impact pathway for waste are shown in Figure 9.

Figure 9. High-level impact pathway for waste



2.2.6.2 Measure your impact driver

To measure your impact driver, you need to measure the mass of waste disposed. Table 28 presents the list of quantitative indicators for the main land cover types you should measure.

Table 28. Quantitative indicators to be measured

Mass of waste disposed to landfill (kg)
Mass of waste incinerated (kg)
Mass of waste disposed to open dump sites (kg)

You will moreover need to measure the composition, including organic content. To perform the next steps, you will need to collect further information on the context and the type of stringency with which waste management is enforced (especially location).

2.2.6.3 Measure changes in the state of natural capital

Implementing models to reflect changes in natural capital, as well as impacts on society and business arising from these changes, takes expert knowledge and you are very likely to need external support for this. It is likely that you will not perform the following actions directly yourself.

The following actions are needed to complete this step:

- **Identify changes in capitals associated with your business activities and impact drivers.** Table 29 presents the list of changes to natural capital that should be assessed.

Table 29. Changes to natural capital to measure for waste

Indicator (impact driver)	Change in natural capital
Waste to landfill (managed)	• Changes in soil and water quality • Changes in GHG emission concentration and GWP (especially methane) • Changes in dioxin and heavy metal concentrations in air
Waste to incineration	• Changes in GHG emission concentration, depending on fossil carbon content • Changes in non-GHG air emission concentration
Waste to open dump sites	• Same changes as waste to landfill occur, but likely greater changes to natural capital • Loss of habitat

- **Measuring change.** To complete this action, you should use a modeling approach**.** Depending on how landfill is managed, gases may be recovered and used for energy generation. Your modeling approach should take into account: composition of waste (e.g., fossil carbon content), management practices (e.g., sealing of landfill sites), energy recovery, energy mix of local electricity grid, and environmental and geological conditions.

2.2.6.4 Value impacts

These are the actions needed to value the consequences of your impacts on society:

- **Define the consequences of impacts and/or dependencies.** You should include the impacts outlined in Table 30.

Table 30. Impacts of waste

Human health
Disamenity
Agricultural yield
Other ecosystem services

- **Select appropriate valuation technique(s) and undertake valuation**
  You should first quantify impacts in physical terms, based on changes in natural capital. Then you should select a method to value your impacts in monetary terms.

  - To perform quantitative valuation (in physical terms) you should select and apply one of the quantitative valuation techniques outlined in Table 31, for each of the impacts assessed.

Table 31. Quantitative valuation techniques to use for waste

Impact category	Quantitative valuation technique
Human health	Dose-response function
Disamenity	In this case, it is recommended that impacts are valued directly in monetary terms without the need for a quantitative physical impact metric
Agricultural yield	Function transfer
Other ecosystem services	Function transfer

  - Monetary valuation: Once you have completed the quantitative valuation, select and apply one of the monetary valuation techniques outlined in Table 32, for each of the impacts assessed.

Table 32. Monetary valuation techniques to use for waste

Impact category	Monetary valuation technique
Human health	Stated or revealed preference approaches
Disamenity	Stated or revealed preference approaches
Agricultural yield	Market prices
Other ecosystem services	Market prices

3 USING THE RESULTS

To finalize your accounting, you need to interpret the results in light of your modeling assumptions.

This section builds on the Apply Steps outlined in the Natural Capital Protocol. For readers more familiar with the terminology of life cycle assessments, this corresponds to the "interpretation" stage.

3.1 Interpret and test the results

There will always be some estimation or approximation involved in a natural capital accounting. To understand what level of confidence you can have in your results, you will need to interpret and validate them. This includes reviewing your modeling assumptions and validating your data inputs.

To interpret and test results, you should: (i) test your key assumptions, (ii) collate results, and (iii) validate the accounting process. You may also consider seeking (external) assurance or verification, particularly if planning to disclose your accounting publicly.

3.1.1 Test key assumptions

To test your key assumptions, you should consider carrying out a sensitivity analysis.

You should also review your modelling assumptions and how they might limit the conclusions to be drawn.

Box 16 provides further information on how to carry out a sensitivity analysis.

Box 16. Sensitivity analysis

Sensitivity analysis involves testing how changes in assumptions or key variables affect the results of an accounting. There are different methods of carrying out a sensitivity analysis, many of which require knowledge of statistics. All methods are designed to help you understand the degree of confidence you can have in your results, without overstating their accuracy.

3.1.2 Collate results

To interpret your results, you first need to compile your resulting data in a way that is appropriate to your natural capital accounting. This is likely to involve some form of analytical approach or framework such as cost-benefit analysis, multicriteria analysis, environmental profit and loss account (EP&L), or total contribution. Collating results provides a means of standardizing calculation methodologies. Additionally, as has been noted with regard to current sustainability reporting practices, when companies present results in non-standardized ways this makes comparisons difficult.

When collating results, you should:

- Present value chain levels separately, acknowledging different levels of control and ability to influence.

- Present impacts separately for each impact driver.
- Provide details on your materiality assessment and justify any exclusions.
- Provide details on both internal and external data sources, as well as an assessment of their quality.
- Explain key modeling assumptions, external and internal model sources and limitations, as well as the results of your sensitivity analysis.
- To avoid the risk of greenwashing, there should be no netting of results, especially when considering a limited number of topics.
- Clearly state where your approach deviates from the recommendations of this methodology.

Including notes similar to those found in financial statements may help other stakeholders interpret the results of your accounting.

3.1.3 Validate and verify the accounting process and results

While validation and verification may cover either the accounting process or the results or both, the benefits of rigorous validation and verification can be significant:

- Validation of the accuracy and completeness of your results may be required by internal colleagues involved in making the decision that your accounting is intended to inform.
- Verification can provide confidence to various stakeholders that the data and methodologies used are fit for purpose and that the accounting results are sufficiently robust to be used as a basis for business decisions and/or external communication.

For these reasons, you should validate and verify your accounting process and results. Depending on the application of the accounting, this can be carried out by internal or external reviewers.

When selecting your assurance provider, consider your business application. If you are planning to integrate natural capital information into your standard corporate reports (annual report, non-financial report), there may be requirements on the type of assurance provider and required level of assurance (limited / reasonable). See Box 17 on levels of assurance.

Box 17. Verification and levels of assurance

Verification is an independent process involving expert review to check that your subject matter (natural capital accounting) gives a (satisfactorily) true representation of the process and results.

The risk of material misstatement can never be reduced to nil, and therefore there can never be absolute assurance. For a **reasonable assurance** engagement, the assurance provider needs to reduce the risk of material misstatement to an acceptably low level as the basis for a positive form of expression of the practitioner's conclusion. For a **limited assurance** engagement, the assurance provider collects less evidence but enough for a negative form of expressing the conclusion.

Given its maturity, limited assurance is most prevalent for sustainability information including natural capital accounting.

3.2 Take action

Note: This topic will be explored in more detail in a separate document as part of the Transparent Project.

3.2.1 Apply and act on results

Depending on your business application, your actions in response to your accounting are likely to differ.

If planning to set targets, you should review your modeling choices in light of your ability to reflect specific management choices.

3.2.2 Communicate results

You may want to communicate your results internally and externally.
Your communicated results should be at an appropriate level of detail and include information on key modeling assumptions as well as limitations.

You should also consider an appropriate level of frequency, depending on your business application. For example, if tracking progress towards a target you may want to communicate interim results monthly or quarterly as part of your management reporting, whereas you may want to report externally only on an annual basis.

Box 18 provides further information on reporting requirements.

Box 18. Natural capital and reporting requirements

At the time of writing, financial accounting and accounting for other capitals (natural, social, human) are treated as separate domains. Conceptually, further work will be needed to link the two. This is explored in a report by the Capitals Coalition (Capitals Coalition 2020).

In general, corporate reporting requirements depend on your location. Whilst there are no specific mandatory provisions on using natural capital accounting for external disclosures, there are overlaps with both financial and non-financial reporting.

In the EU, in particular, the revised Non-Financial Reporting Directive (in future: Corporate Sustainability Reporting Directive) requires companies to report on environmental aspects following a "double materiality" definition (see Figure 2). Natural capital accounting may be a useful tool for this.

Note: You can find illustrative examples of the outputs from using the results in Annex I.

ANNEX I. ILLUSTRATIVE EXAMPLES

To help you navigate the Transparent methodology we include two illustrative examples. These examples simplify actions and decisions to demonstrate how Transparent methodology works and what hypothetical companies did as result of its application.

Note: Please note that the illustrative examples included here will be further developed based on input from the public consultation, further development of the Transparent methodology, and learnings from the piloting.

Table 33. Illustrative example: Auto Parts Inc. - Scope

Scoping elements	**Outputs of illustrative example on scoping elements**
Context	Auto Parts Inc. is a manufacturing company producing components for vehicles. As part of a review of their wider corporate strategy, they have decided to assess the environmental impacts on society of their business, as they are expecting environmental topics and resource constraints to dominate future market trends and legislation particularly of the transportation sector
Target audience	Senior management, corporate strategy
Objective	Identify hotspots of environmental impacts across the value chain for different business segments
	Use results for projections supporting development of the new corporate strategy, including risk mitigation opportunities
Organizational focus	Corporate / consolidated group level
Level of detail required	Following operational organizational structure: breakdown of impacts by • Business segment • Product group • Distribution channel • Location (country/region)
Value-chain boundary	Full value chain, with the following subdivisions: • Upstream – raw materials used in production • Upstream – indirect procurement (IT, services, facility management, etc.) • Own operations – manufacturing sites • Own operations/downstream – distribution logistics • Downstream – use phase • Downstream – end of life
Impacts to be covered	GHG emissions, non-GHG air emissions, water consumption, water pollution, land use, waste
Value perspective	Value to society
Accounting period	Impacts triggered by activities in financial year 2020
	Projections of impacts triggered by planned activities in financial year 2025
Technical issues to consider	Allocation – which portion of downstream impacts to attribute to Auto Parts Inc.

Table 34. Illustrative example: Auto Parts Inc. – measuring impact drivers and data

Data sources	**Considerations regarding specificity and practical implementation**
LCA databases	Need separate data sets for - key sourcing countries - key materials / processes There is an LCA team already working with a particular LCA software partner; build on this
Multiregional extended IO model	Need multiregional model, as sourcing from many different parts of world No inhouse capabilities for this; need external partner
Waste disposal statistics	Cover key markets covering 70% of sales
Data from internal systems	Need to match product categories / segments across different systems Mapping exercise needed, likely to take some time and effort
Consolidation of data	Need to be able to perform various types of drill-down Set up team with data modeling capabilities

Table 35. Illustrative example: Auto Parts Inc. - measuring impact drivers and data per value chain level

Value chain level	Internal data sources for measuring impact drivers	Secondary data sources
Upstream – raw materials	Production planning system	LCA data sets, specific to key countries and processes
Upstream	Procurement system covering 90% of indirect purchasing volumes, scaled up to 100% via personnel	Multiregional extended IO model
Own operations – manufacturing sites	Environmental management systems covering 80% of sites, scaled up to 100% via production volumes	-
Own operations – other sites	(Excluded as not material)	-
Own operations /downstream – distribution logistics	Mode split from operational logistics system	LCA data sets, specific to key countries and modes
Downstream – use phase	Product specifications (average / modeled) Sales data	LCA data sets, specific to key countries and processes
Downstream – end of life	Sales data Product specifications (average / modeled)	LCA data sets, specific to key countries and processes Waste disposal statistics from public sources

Table 36. Illustrative example 1: Auto Parts Inc. - measuring changes in state of natural capital

Context	**Hotspot analysis across full value chain**
Level of detail required	Reflecting (operational) structure is most important to Auto Parts Inc. Given the complex value chain both upstream and downstream, they are most interested in being able to break down results by location, aggregated at country level. They are less interested in accurate data regarding specific changes to natural capital at a site level.
Approach for modeling changes to natural capital	Auto Parts Inc. are not modeling changes to natural capital directly but relying on external data sets that translate emission drivers directly to (monetized) impacts. In choosing a provider, they are focusing on a broad coverage of regional-/country-level variations that they can apply to their worldwide operations.

Table 37. Illustrative example 2: Widgets Ltd. - Measuring changes in the state of natural capital

Context	**Use natural capital information to inform choice of manufacturing site**
Level of detail required	Regarding own operations, Widget Ltd. are interested in understanding how a new production site would interact with local natural capital and ecosystems for two distinct and known locations. Other elements of the value chain (upstream, downstream) do not require this level of detail.
Approach for modeling changes to natural capital	They are working with environmental experts to investigate more accurately how the extent and quality of local ecosystems would be affected. For the rest of the value chain, they are using standard data sets that translate impacts directly.

Here you can find different templates together the results of a natural capital accounting exercise. Please note that there are illustrative and different templates are possible. As the Transparent methodology focuses on management accounting it does not provide a standardized way of reporting and communicating the results of natural capital accounting.

Environmental P&L

		Value chain stages						
		Downstream	Own Operations	Upstream - TIER 1	Upstream - TIER 2	Upstream - TIER 3	Upstream - TIER 4	TOTAL (mill.)
Impact drivers	GHG emissions							
	Non-GHG emissions							
	Water consumption							
	Water pollution							
	Land use							
	Waste							
	TOTAL (mill.)							

Integrated P&L

		Value chain stages		
Capitals	**Impact drivers**	**Upstream**	**Own Operations**	**Downstream**
Produced	**Net income**			
	Amortization and depreciation			
Human and Social	**Taxes**			
	Wages & benefits			
	Capacity building			
	Health and safety			
Natural	**GHG emissions**			
	Non-GHG emissions			
	Water consumption			
	Water pollution			
	Land use			
	Waste			

ANNEX II. DATA SOURCES AND APPROACHES

This Annex contains further information on data sources and approaches that your natural capital accounting may build on:

1. Life cycle assessment
2. Environmentally extended input-output modeling

It also provides background information on selected related approaches and initiatives:

3. Product & Organization Environmental Footprint
4. Life Cycle Initiative

II.1 Life cycle assessment (LCA)

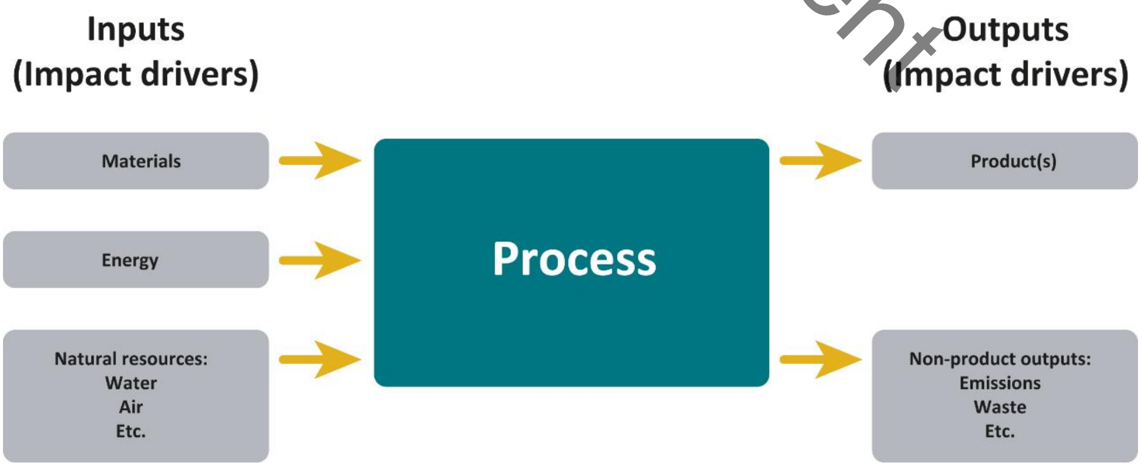
II.1.1 About LCA

Life cycle assessment (LCA) is technique used to assess the environmental (i.e., natural capital) effects of a company, product or service through all stages of its life cycle, from material extraction to end-of-life (disposal, recycling or reuse). This is codified in two ISO standards, ISO 14040 and ISO 14044. It should be noted that the definition of "impacts" used in LCA differs from that used in natural capital accounting following the Natural Capital Protocol, which is the definition used in this document.

Life cycle assessment is implemented through four stages: (i) Goal and Scope; (ii) Inventory analysis; (iii) Impact assessment and (iv) Interpretation.

One of the key steps is the creation of a life cycle inventory (LCI), which reflects flows to and from nature for a product system. As such, LCA relies on a bottom-up approach, analyzing inputs (i.e., resource use) and outputs (i.e., emissions to air) from specific processes such as electricity production, material production or processing, transportation means, etc. (see also Figure 10).

Figure 10: Inputs, processes and outputs



Life cycle impact assessment (LCIA) is the step that links a life cycle inventory to environmental impact categories and indicators. LCIA consists of the classification and characterization of impacts, as well as normalization and weighting. According to ISO 14040, normalization and weighting are optional, whereas they are mandatory according to PEF and OEF. The Life Cycle Impact Assessment roughly corresponds to the quantification of changes in the stock of natural capital, as well as the valuation step.

Methods for categorizing life cycle impacts are usually published by academic institutes and cover a wide range of impact categories. **It should be noted that, while similar, LCA impact categories are not the same as "impacts" as defined in the Natural Capital Protocol**.

LCA impact categories can be either "midpoints" or "endpoints", where midpoints usually (though not exclusively) reflect individual environmental concerns and hence changes to specific aspects of natural capital, and endpoints reflect impacts further along a cause-chain effect (impact pathway). Typical midpoints include climate change, eutrophication, land use, mineral and fossil resource depletion, acidification, ozone depletion, terrestrial and marine ecotoxicity, ionizing radiation, photochemical ozone formation, water depletion, human toxicity. Endpoints are the usually categorized as the three areas of protection: human health, ecosystem health and natural resources. Following the impact pathway logic used in this document, LCA midpoint "impacts" are more closely related to changes in natural capital, whilst LCA endpoint "impacts" are closer to the impacts used here.

To quantify LCA "impacts", characterization factors are used, which are published by academic institutes and the UN Life Cycle Initiative. Characterization factors may refer to midpoints or to endpoints. Endpoints are usually more uncertain than midpoints.

For instance, in LCA, climate change impacts are characterized at midpoint level through the Global Warming Potential. The endpoint for climate change in LCA would be the direct measure of human health and ecosystem impact, which is more complex to assess and more uncertain.

II.1.2 Practical use of LCA in natural capital accounting

LCA model and database providers have a vast array of standard product systems and data sets, reflecting the "typical" conversions of inputs to outputs through a process. This covers both unit processes modeling an individual process, as well as more complex system data sets aggregating multiple unit processes.

Such standard data sets are often a useful basis for natural capital accounting following this methodology, as they may help estimate impact drivers associated with a given (unit) product or process (e.g., emissions from 1kg of PET produced, or from 1 ton-km of transportation). Data sets offered by LCA database providers refer to specific geographic, temporal and technological conditions. Therefore, you may need to adapt data sets to your needs (e.g., using different energy inputs for different locations, or combining unit processes to create new aggregate systems). Unless you have specific in-house LCA expertise, you are likely to need external support for this. The Global LCA Data Access website allows searching for data sets across different providers.

II.2 Environmentally extended input-output models (EEIO)

II.2.1 About EEIO

In economics, an input–output model is a quantitative economic model that represents the interdependencies between different sectors of a national economy or different regional economies. Traditional input-output (IO) tables summarize the exchanges between major sectors of an economy (Miller and Blair 2009). In an IO model, one unit of demand (in a given currency) in one sector and region triggers demand in other sectors and regions.

For example, output from the footwear manufacturing sector results in economic activity in associated sectors, from cattle ranching, manufacturing, logistics to accounting services. Therefore, an IO model offers an econometric approach for modeling the full value chain. Multiregional input-output (MRIO) tables further summarize the exchanges between different economies, thereby offering some regional specificity.

Environmentally extended input-output models (EEIOs) are based on traditional economic models and integrate satellite accounts - information on the environmental data (e.g., emissions) of each sector within input-output tables (Kitzes 2013; Leontief 1970; Tukker et al. 2006). This allows estimating environmental impact drivers based on monetary flows, across the whole value chain, using what is essentially a top-down approach.

II.2.2 Practical use of EEIO in natural capital accounting

EEIOs can be used to measure impact drivers using a company's financial data (e.g., procurement data) as a measure of business impact drivers. In practical terms, categories used in internal data capture need to be mapped to sectors and countries in an EEIO model. The results essentially reflect sector averages, which may limit their usefulness to your business application.

As with LCA, you are likely to need external support when applying EEIO modeling. There are a number of different providers available, whose solutions are based on different underlying models. These may differ in terms of:

- Satellite accounts (i.e., which impact drivers they can quantify)
- Sector resolution
- Geographic resolution
- Temporal reference (i.e., when the underlying data were last updated and to what extent trade flows at that time are still representative today)

Table 38 provides examples of which data sources may be useful for which value chain level.

Table 38. Data sources for different value chain levels.

Value chain level	Example of data sources
Own operations	Direct measurement or proxy indicators (such as energy and fuel use) Secondary data sources (e.g., life cycle assessment databases or emission factors

Immediate / key suppliers	Supplier questionnaires requesting information about environmental data or proxy indicators (e.g., energy or fuel consumption) Environmentally extended input-output analysis (EEIO) LCA databases
Upstream supply chain	Environmentally extended input-output analysis (EEIO) gives an approximation of impact drivers based on purchasing data LCA databases for more process-specific data Other secondary data sources, including government and industry reports (e.g., Intergovernmental Panel on Climate Change (IPCC), International Energy Agency)
Downstream (further processing, use phase, end of life	Environmentally extended input-output (EEIO) analysis using your sales data, coupled with modeling of consumer habits (e.g., energy use, water use) and end of life (EoL) scenarios Life cycle assessment (LCA) databases Other secondary data sources, public reports / studies / country statistics (e.g., on waste disposal)

II.3 Product Environmental Footprint (PEF) and Organization Environmental Footprint (OEF) method

The European Commission (including the Joint Research Centre, JRC IES) has been working towards the development of a harmonized methodology for the calculation of the environmental footprint of products and organizations, building on LCA approaches.

The final impact assessment method, applied for the Product Environmental Footprint (PEF) and Organization Environmental Footprint (OEF) was published as an Annex to the Commission Recommendation on the use of common methods to measure and communicate the life cycle environmental performance of products and organizations. It covers 16 environmental categories defined at midpoint level.

The detailed documentation on the PEF/OEF method has been published by the EU Commission online (EPLCA 2019).

II.4 Life Cycle Initiative

The Life Cycle Initiative is a public-private, multi-stakeholder collaboration, including governments, businesses and scientific and civil society organizations. Hosted by UN Environment, the Life Cycle Initiative is at the interface between users and experts of life cycle approaches.

It provides a global forum for a science-based, consensus-building process to support decisions and policies towards the shared vision of sustainability as a public good, delivering an opinion accepted by multiple stakeholders on sound tools and approaches.

In 2013 the Initiative launched a global process to standardize life cycle impact assessment (LCIA) categories and indicators. It should be noted that some of the categories defined through this process are theoretical, in the sense that there are no or only limited models available that implement them. The data and frameworks are available in: https://www.lifecycleinitiative.org/

ANNEX III. TECHNICAL ADDITIONS FOR VALUATION OF IMPACTS

This Annex provides further technical description of some aspects related to the valuation of impacts. These are related to:

1. Existing sources of the Value per Statistical Life per Year
2. Breakdown of the discount rate.

III.1 Existing sources of the Value per Statistical Life per Year

Some of the few existing sources of Value per Statistical Life Year (VSLY) are: Desaigues et al., (2007, 2011); Hurley et al. (2005) and Holland (2014).

Table 39 provides some examples of Values per Statistical Life Year widely used in policy analysis (Narain and Sall, 2016).

Table 39. Example of guideline Value per Statistical Life Year estimates used by public agencies.

National or regional agencies user of the values	**Value per Statistical Life Year (VSLY)** (2011 U.S. dollars, Power Purchase Parity)
United Kingdom – Department of Environment and Rural Affairs (DEFRA)	24,000 (acute) 46,000 (chronic)
Norway - Ministry of Finance	49,000
Australia - Office of Best Practice Regulation (OBPR)	111,000
European Commission – Directorate General for the Environment	82,000-184,000

Sources: Australia OBPR (2014), Holland (2014), OECD (2012) and UK Defra (2007)

Note: All values adjusted to year 2011 prices using national or regional (Euro area) consumer price index and converted to U.S. dollars at Power Purchase Parity rates.

III.2 Breakdown of the discount rate

As described by HMT (2020), the social discount rate (r) has two components: the time preference (ρ) and the wealth effect (μg), as indicated in the following expression:

$$r = \rho + \mu g$$

Time preference (ρ)

This component captures the preference for current consumption, assuming no change in per capita consumption. This comprises the sum of two components: the pure time preference (δ) and the catastrophic risk (L).

$$\rho = \delta + L$$

Here you can find further explanation of these components and suggestions about their values:

- **Pure time preference** (δ) represents the desire to have income or well-being today rather than in the future, assuming that no catastrophes will happen. Empirical studies show that this rate could be 0-1% (Freeman, Groom and Spackman 2018).

  Valuing the well-being of future generations as equal to our own can be considered ethically defensible and aligned with notions of intergenerational equity commonly found in the climate change literature.

  Consequently, this methodology recommends using a pure time preference (δ) equal to 0, as default, as this ensures that potential risks related to natural capital impacts and dependencies are not hidden.

- **Catastrophic risk (L)** reflects the changes in consumer preference as consequence of unpredictable risks happening, such as 'catastrophic' or 'systemic' risk (L). Empirical studies show estimates of 1% for this component.

Wealth effect (μg)

This component captures the loss of utility of future consumption, as consumption tends to increase due to increases in per capita income. This component should be excluded of the social discount rate (μg=0) when assessing the risk to health and life.

The wealth effect comprises the multiplication of two components: the marginal utility of consumption (μ) and the expected growth rate of future real per capita consumption (g). Here you can find further explanation of these components and suggestions about their values:

- **Marginal utility of consumption (μ).** Empirical studies show that this rate could be 1-1.5% (HMT 2003, Layard et al. 2008, Groom and Maddison 2018).

- **Expected growth rate of future real per capita consumption (g).** This information is published by public statistical offices and depends on each country and on the duration and specific time period considered to calculate the rate. Users should make clear which time period was considered (i.e., from 1950-2020), as well as the country/countries considered for the rate chosen.

Box 19 provides the recommended values to be used for these components when using Transparent methodology, by default.

Box 19. Recommended default values of social discount rate

For the purposes of this methodology, these are the values recommended, as default:

- When assessing the risk on health, use a social discount rate (r) of 1%
  - δ is retained at 0%
  - L is retained at 1%
  - ρ is therefore 1%
  - μg is retained a 0%

- When assessing other risk (different than health): calculate the social discount rate (r) considering these indications:
  - δ is retained at 0%
  - L is retained at 1%
  - ρ is therefore 1%
  - μ is 1%
  - g is retained as the expected growth rate of future real per capita consumption

GLOSSARY

Baseline	In the Protocol, the starting point or benchmark against which changes in natural capital attributed to your business' activities can be compared.
Biodiversity	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 (UN 1992).
Business application	In the Protocol, the intended use of the results of your natural capital assessment, to help inform decision making.
Counterfactual	A form of scenario that describes a plausible alternative situation, and the environmental conditions that would result if the activity or operation did not proceed (adapted from Schaafsma and Cranston 2013).
Economic value	The importance, worth, or usefulness of something to people—including all relevant market and non-market values. In more technical terms, the sum of individual preferences for a given level of provision of that good or service. Economic values are usually expressed in terms of marginal/incremental changes in the supply of a good or service, using money as the metric (e.g., $/unit).
Ecosystem	A dynamic complex of plants, animals, and microorganisms, and their non-living environment, interacting as a functional unit. Examples include deserts, coral reefs, wetlands, and rainforests (MEA 2005). Ecosystems are part of natural capital.
Ecosystem services	The most widely used definition of ecosystem services is from the Millennium Ecosystem Assessment (MEA 2005): "the benefits people obtain from ecosystems". The MEA further categorized ecosystem services into four categories: – Provisioning: Material outputs from nature (e.g., seafood, water, fiber, genetic material). – Regulating: Indirect benefits from nature generated through regulation of ecosystem processes (e.g., mitigation of climate change through carbon sequestration, water filtration by wetlands, erosion control and protection from storm surges by vegetation, crop pollination by insects). – Cultural: Non-material benefits from nature (e.g., spiritual, aesthetic, recreational, and others). – Supporting: Fundamental ecological processes that support the delivery of other ecosystem services (e.g., nutrient cycling, primary production, soil formation).
Environmentally extended input-output models (EEIO)	Traditional input-output (IO) tables summarize the exchanges between major sectors of an economy (Miller and Blair 2009). For example, output from the footwear manufacturing sector results in economic activity in associated sectors, from cattle ranching to accounting services. Environmentally extended input-output models (EEIOs) integrate information on the environmental impacts of each sector within IO tables (Kitzes 2013; Leontief 1970; Tukker et al. 2006).

Externality	A consequence of an action that affects someone other than the agent undertaking that action, and for which the agent is neither compensated nor penalized. Externalities can be either positive or negative (WBCSD et al. 2011).
Impact	See "natural capital impact"
Impact driver	In the Protocol, an impact driver is a measurable quantity of a natural resource that is used as an input to production (e.g., volume of sand and gravel used in construction) or a measurable non-product output of business activity (e.g., a kilogram of NO_x emissions released into the atmosphere by a manufacturing facility).
Impact pathway	An impact pathway describes how, as a result of a specific business activity, a particular impact driver results in changes in natural capital and how these changes in natural capital affect different stakeholders.
Life cycle assessment	Also known as life cycle analysis. A technique used to assess the environmental impacts of a product or service through all stages of its life cycle, from material extraction to end of life (disposal, recycling or reuse). The International Organization for Standardization (ISO) has standardized the LCA approach under ISO 14040 (UNEP 2015). Several life cycle impact assessment (LCIA) databases provide a useful library of published estimates for different products and processes.
Materiality	In the Protocol, an impact or dependency on natural capital is material if consideration of its value, as part of the set of information used for decision making, has the potential to alter that decision (Adapted from OECD 2015 and IIRC 2013).
Materiality assessment	In the Protocol, the process that involves identifying what is (or is potentially) material in relation to the natural capital assessment's objective and application.
Measurement	In the Protocol, the process of determining the amounts, extent, and condition of natural capital and associated ecosystem and/or abiotic services, in physical terms.
Monetary valuation	Valuation that uses money (e.g., $, €, ¥) as the common unit to assess the values of natural capital impacts or dependencies.
Natural capital	The stock of renewable and non-renewable natural resources (e.g., plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people (adapted from Atkinson and Pearce 1995; Jansson et al. 1994).
Natural capital assessment	The process of measuring and valuing relevant ("material") natural capital impacts and/or dependencies, using appropriate methods.
Natural capital dependency	A business reliance on or use of natural capital.
Natural capital impact	The negative or positive effect of business activity on natural capital.
Natural Capital Protocol	A standardized framework to identify, measure and value direct and indirect impacts (positive and negative) and/or dependencies on natural capital.
Organizational focus	In the Protocol, the part or parts of the business to be assessed (e.g., the company as a whole, a business unit, or a product, project, process, site, or incident). For simplicity, these are

	grouped under three general headings as below: − Corporate: assessment of a corporation or group, including all subsidiaries, business units, divisions, different geographies or markets, etc. − Project: assessment of a planned undertaking or initiative for a specific purpose, and including all related sites, activities, processes, and incidents. − Product: assessment of particular goods and/or services, including the materials and services used to produce these products.
Price	The amount of money expected, required, or given in payment for something (normally requiring the presence of a market).
Primary data	Data collected specifically for the assessment being undertaken.
Qualitative valuation	Valuation that describes natural capital impacts or dependencies and may rank them into categories such as high, medium, or low.
Quantitative valuation	Valuation that uses non-monetary units such as numbers (e.g., in a composite index), areas, mass, or volume to assess the magnitude of natural capital impacts or dependencies.
Scenario	A storyline describing a possible future. Scenarios explore aspects of, and choices about, the future that are uncertain, such as alternative project options, business as usual, and alternative visions.
Scoping	In the Protocol, the process of determining the objective, boundaries, and material focus of a natural capital assessment.
Secondary data	Data that were originally collected and published for another purpose or a different assessment.
Spatial boundary	The geographic area covered by the assessment, for example, a site, watershed, landscape, country, or global level. The spatial boundary may vary for different impacts and dependencies and will also depend on the organizational focus, value-chain boundary, value perspective, and other factors.
Stakeholder	Any individual, organization, sector, or community with an interest or “stake” in the outcome of a decision or process.
Temporal boundary	The time horizon of the assessment. This could be a current “snapshot”, a 1-year period, a 3-year period, or a 25-year period, or longer.
Validation	Internal or external process to check the quality of the assessment, including technical credibility, the appropriateness of key assumptions, and the strength of your results. This process may be more or less formal and often relies on self-assessment.
Valuation	In the Protocol, the process of estimating the relative importance, worth, or usefulness of natural capital to people (or to a business), in a particular context. Valuation may involve qualitative, quantitative, or monetary approaches, or a combination of these.
Valuation technique	The specific method used to determine the importance, worth, or usefulness of something in a particular context.
Value (noun)	The importance, worth, or usefulness of something.
Value perspective	In the Protocol, the perspective or point of view from which value is assessed; this largely determines which costs or benefits are included in an assessment.

	− Business value: The costs and benefits to the business, also referred to as internal, private, financial, or shareholder value. − Societal values: The costs and benefits to wider society, also referred to as external, public, or stakeholder value (or externalities).
Value transfer	A technique that takes a value determined in one context and applies it to another context. Where contexts are similar or appropriate adjustments are made to account for differences, value transfer can provide reasonable estimates of value.
Value-chain boundary	The part or parts of the business value chain to be included in a natural capital assessment. For simplicity, the Protocol identifies three generic parts of the value chain: upstream, direct operations, and downstream. An assessment of the full lifecycle of a product would encompass all three parts. − Upstream (cradle-to-gate): covers the activities of suppliers, including purchased energy. − Direct operations (gate-to-gate): covers activities over which the business has direct operational control, including majority-owned subsidiaries. − Downstream (gate-to-grave): covers activities linked to the purchase, use, reuse, recovery, recycling, and final disposal of the business' products and services.
Verification	Independent process involving expert assessment to check that the documentation of the assessment is complete and accurate and gives a true representation of the process and results. "Verification" is used interchangeably with terms such as "audit" or "assurance".
Visibility	Air emissions, particularly PM and O_3 precursors, contribute to reduced visibility through the formation of smog. Reduced visibility affects various methods of navigation and reduces people's enjoyment of recreational sites and the neighborhoods where they live (i.e., disamenity).

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LIST OF FIGURES AND TABLES

LIST OF ACRONYMS

AWARE – Available Water Remaining

CE – choice experiment

CSRD – Corporate Sustainability Reporting Directive

CV – contingent valuation

DALY – Disability-adjusted life year

EEIO – Environmentally extended input-output model

EFRAG – European Financial Reporting Advisory Group

EoL – End of life

EP&L – Environmental Profit and Loss Account

GDP – gross domestic product

GHG – greenhouse gas

GTP – Global Temperature change Potential

GWP – Global Warming Potential

IMF – International Monetary Fund

IO – input-output model

IPCC – Intergovernmental Panel on Climate Change

ISO – International Organization for Standardization

JRC - Joint Research Centre

LCA – life cycle assessment

LCI – life cycle inventory

LCIA – life cycle impact assessment

MRIO – multiregional input-output

NOx – nitrogen oxides

OEF – Organization Environmental Footprint

PEF – Product Environmental Footprint

PPP – purchasing power parity

PRTP – pure rate of time preference

R&D – research and development

SCC – social cost of carbon

SEEA – System of Environmental Accounting

SFDR – Sustainable Finance Disclosure Regulation

UNEP – United Nations Environment Programme

VBA – Value Balancing Alliance

VOC – volatile organic compounds

VSL – value of a statistical life

VSLY – value per statistical life year

WASH – water access, sanitation and hygiene

WBCSD – World Business Council for Sustainable Development

WFN – Water Footprint Network

WRI – World Resources Institute

WSI – Water Scarcity Index

YLD – years lost due to disability

YLL – years of life lost

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ABOUT

The Value Balancing Alliance is an alliance of multinational companies with the common goal to develop a standardized methodology to ensure greater sustainability and transparency in business. The Alliance translates environmental and social impacts into comparable financial data, and the member companies pilot the methodology to ensure feasibility, robustness, and relevance. It is supported by the "Big 4" professional services firms Deloitte, EY, KPMG and PwC in a pro bono capacity.

The Capitals Coalition is a global collaboration transforming the way decisions are made by including the value provided by nature, people, and society. Our ambition is that by 2030 the majority of business, finance, and government will include all capitals in their decision making, and that this will deliver a more fair, just, and sustainable world.

The World Business Council for Sustainable Development is a CEO-led organization of over 200 international companies. It was created in 1995 and works to achieve the Sustainable Development Goals (SDGs) through the transformation of six economic systems. These are Circular Economy, Cities and Mobility, Climate and Energy, Food and Nature, People and Society and Redefining Value. Each system transformation is set up as a WBCSD Program with a number of supplementary projects.