UN environment programme

Nature Risk Profile

A methodology for profiling nature related dependencies and impacts

S&P Global

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List of abbreviations

EII	Ecosystem Integrity Index
ENCORE	Exploring Natural Capital Opportunities, Risks and Exposure
ESG	Environmental, Social and Governance
GRI	Global Reporting Initiative
IBAT	Integrated Biodiversity Assessment Tool
ICCA	Indigenous and Community Conserved Areas
KBA	Key Biodiversity Area
OECM	Other Effective Conservation Measures
STAR	Species Threat Abatement and Restoration
TNFD	Taskforce on Nature-related Financial Disclosures

Terms and definitions

Term	Definition
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 (Convention on Biological Diversity, 1992).
Cumulative impact	A change to the state of natural capital that occurs due to the interaction of activities of different actors operating in a landscape, not only the target organisation (as referenced in TNFD Beta framework).
Dependencies	Aspects of ecosystem services that an organisation or other actor relies on to function. Dependencies include ecosystems' ability to regulate water flow, water quality, and hazards like fires and floods; provide a suitable habitat for pollinators (who in turn provide a service directly to economies), and sequester carbon (in terrestrial, freshwater and marine realms) (as referenced in TNFD Beta framework).
Direct impact	A change in the state of natural capital caused by a business activity with a direct causal link (as referenced in TNFD Beta framework).
Ecosystem condition	"The quality of an ecosystem measured in terms of its abiotic and biotic characteristics. Condition is assessed with respect to an ecosystem's composition, structure and function which, in turn, underpin the ecological integrity of the ecosystem, and support its capacity to supply ecosystem services on an ongoing basis" (as referenced in TNFD Beta framework).
Ecosystem services	The contributions of ecosystems to the benefits that are used in economic and other human activity, drawn from UN-SEEA (2021) System of Environmental-Economic Accounting-Ecosystem Accounting (as referenced in TNFD Beta framework).
Impacts	Changes in the state of nature, which may result in changes to the capacity of nature to provide social and economic functions. Impacts can be positive or negative. They can be the result of an organisation's or another party's actions and can be direct, indirect or cumulative (as referenced in TNFD Beta framework).
Indirect impact	A change in the state of natural capital caused by a business activity with an indirect causal link (e.g. indirectly caused by the climate change and greenhouse gas emissions)
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 (as referenced in TNFD Beta framework).
Nature	The natural world, with an emphasis on the diversity of living organisms (including people) and their interactions among themselves and with their environment (as referenced in TNFD Beta framework).
Nature-related risks	Potential threats posed to an organisation linked to their and wider society's dependencies on nature and nature impacts. These can derive from physical, transition and systemic risks (as referenced in TNFD Beta framework).
Provisioning services	"The contributions to benefits that are extracted or harvested from ecosystems (e.g. timber and fuel wood in a forest, freshwater from a river)" (as referenced in TNFD Beta framework).
Resilience (of ecosystems)	"The level of disturbance that an ecosystem or society can undergo without crossing a threshold that creates different structures or outputs. Resilience depends on factors such as ecological dynamics and the organisational and institutional capacity to understand, manage and respond to these dynamics" (IPBES 2019, as referenced in the TNFD Beta framework).

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00
Executive summary

Our current global economic and financial systems have an unsustainable relationship with nature. We are depleting nature at unprecedented rates, with over one million species at risk of extinction. Yet, more than half the world's economic output (US$44 trillion) is moderately or highly dependent on nature and its services. We are therefore exposed to risks that will arise from the loss of nature.

While we are making progress on building climate into decision making, all actors across society now need to also act on nature. This includes businesses and financial institutions that have a key role to play in the move towards a nature positive economy. Currently, businesses and financial institutions lack the knowledge, capacity and data that they need to understand, mitigate and disclose the nature-related risks that they face.

The Taskforce on Nature-related Financial Disclosures (TNFD) is bringing much-needed clarity on how organizations can start to incorporate nature-related risks and opportunities into their strategic planning, risks management and asset allocation decisions.

The methodology that we present here is a first iteration that draws heavily on the principles outlined by the Taskforce on Nature-related Financial Disclosures (TNFD) in its Beta framework. It is a methodology for profiling nature-related risks associated with location-specific business activities. It allows reporting entities to respond to the TNFD by supporting implementation of the TNFD framework by Environmental, Social and Governance (ESG) analytics providers. It can draw on both disclosed and third-party company data. The methodology rests on two core building blocks for profiling nature-related risks, dependencies on nature and impacts on nature. We break these down into components that help to profile nature-related risks that can be assessed using company data and global nature-related datasets. We provide formulae and supplementary material to support application of this methodology by businesses and financial institutions.

Our development of this methodology has benefited from the input of multiple experts within the conservation community, the finance sector and businesses. While this first version of the methodology enables action on nature by businesses and financial institutions, we recognize that it will need to evolve in the future. We also identify key priorities for further development in the document. We will continuously review these to account for developments in the field, particularly those of the TNFD as well as the post-2020 global biodiversity framework of the Convention on Biological Diversity.

01
Introduction

The global economy is fully dependent on nature, yet it is driving nature loss at unprecedented rates (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES]; World Economic Forum [WEF] and PricewaterhouseCoopers [PwC] 2020) For example, while global Produced Capital per capita increased by over 90% between 1992 and 2014, natural capital decreased by over 30% (Dasgupta 2021). The reduced flow of ecosystem services and associated increased attention by policy makers, consumers, civil society and financial institutions means businesses are facing an ever-increasing level of nature-related risks. For businesses to thrive in the years ahead, it is imperative that these risks are effectively identified, measured and mitigated.

Businesses and investors need access to curated and comprehensive nature-related data. They also need comparable and meaningful metrics to effectively screen their operations and portfolios for nature-related risks and the associated principles such as gender equality and human rights.

These risks can then be considered during decision-making to shift financial flows towards more sustainable outcomes. Nature-related Environmental, Social and Governance (ESG) information can be generated through business-led disclosure and third-party assessments. ESG analytics providers are a practical route by which the emerging Taskforce on Nature-related Financial Disclosures (TNFD) framework can be implemented in practice.

This document first summarizes the links between business impacts and dependencies on nature and risk (current section). It then outlines the structure of the methodology for profiling nature-related risks of businesses (section 2) before presenting the methodology itself (sections 3 and 4). This information can also form the basis of improved ESG performance ratings and the development of nature-related indices.

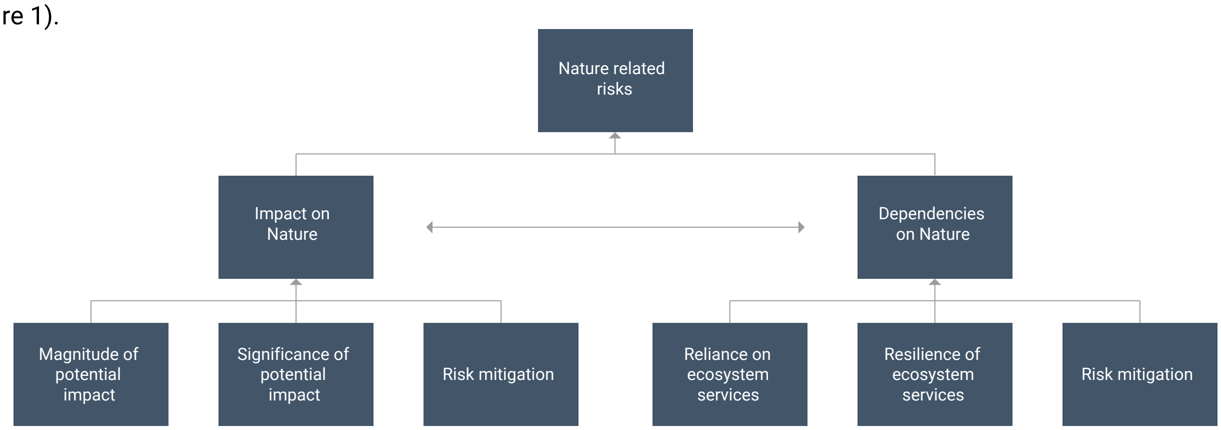
1.1
Risks relating to dependencies and impacts on nature

The methodology presented in the following sections rests on the principles outlined directly below. These focus on two key lenses for assessing a business' nature-related risks: dependencies and impacts (see Figure 1).

Figure 1

Key elements forming the building blocks of the methodology for profiling nature-related risks.

Readers should note that a company can impact on nature that other groups depend upon and also impact on nature that it depends on for its activities. This is represented in the figure by the double arrow between impacts on nature and dependencies on nature.



Introduction

The methodology presented here is a first version that will be built upon in the future. The intention is for it to move towards becoming a methodology that fully captures double materiality based on the best available data (see Box 1). Several key priorities for further development have already been identified (see further down) and will be addressed in future iterations following the publication of this first version. As well as a focus on financial materiality of risks and opportunities, priorities also include the need to build on the connections between nature and people and to cover impacts on vulnerable and/or marginalized communities, including women and girls who are often most affected by the loss of nature and ecosystem services (The United Nations Entity for Gender Equality and the Empowerment of Women [UN Women] 2018; World Economic Forum and PwC 2020).

Box 1. A note on double materiality

There is a need to fully consider the materiality of business impacts from different perspectives. This is often referred to as double materiality. In the context of nature, double materiality would refer to how nature may impact the organization's immediate financial performance (outside-in) and how the organization impacts nature, and the consequences for both business and society (inside out). In other words, businesses need to consider how nature loss, because of their own activities or those of others, may not only negatively affect their own performance, but also affect the activities of others in society, particularly vulnerable groups including women and girls, youth and Indigenous Peoples and local communities (UN Women 2018; World Economic Forum and PwC 2020). Within the mining sector for example, unsustainable and unscrupulous practices, often associated with cheap and exploitative labour, have in some cases put the health and wellbeing of women and children at risk through pollution of the local environment. As such, gender and child-related safeguards are included in most universal frameworks including the Minamata Convention on Mercury to halt these practices and to protect the lives of the most vulnerable populations. These populations are often heavily reliant on natural resources yet have the least adaptive capacities to adjust to reduced access to natural resources.

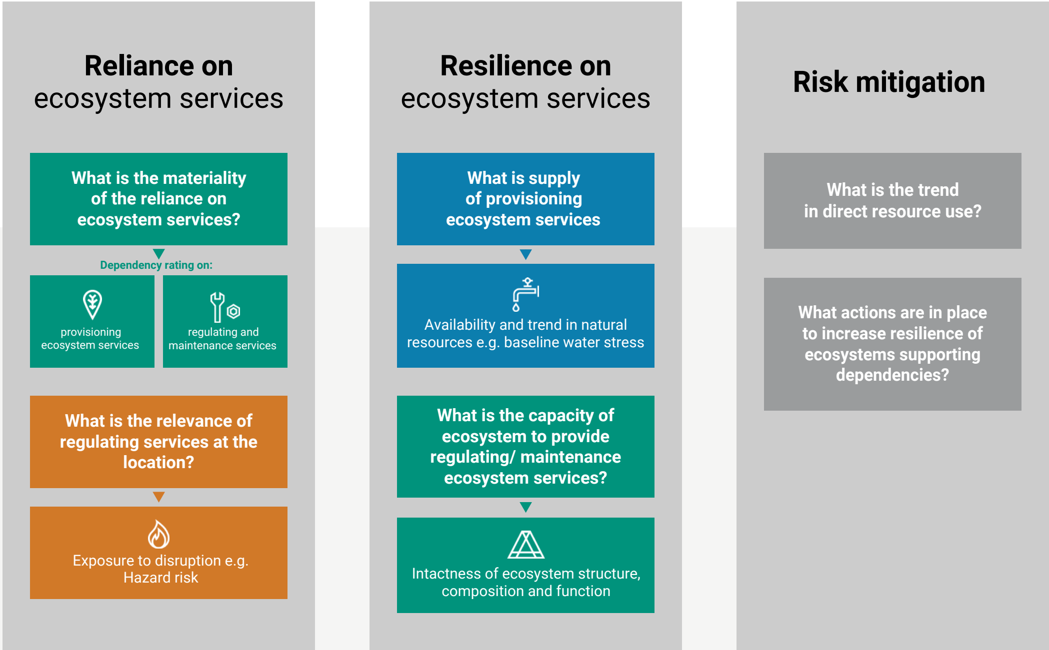
1.1.1
Dependency based risk

The TNFD has defined dependencies as aspects of ecosystem services that an organization or other actor relies on to function. This includes provisioning services such as water flow and regulating and maintenance services such as the mitigation of hazards like fires and floods, and the sequestration of carbon. The dependency of a business on ecosystem services for its operations and business continuity may either be direct or through its supply chain. Risks associated with dependencies are highly material where a business' production operations cannot readily continue in a financially viable manner in the absence of ecosystem services. For example, mining businesses are heavily dependent on a supply of water. As such, a mining business would be at greater risk if one of its mines might no longer be able to access sufficient water from its existing sources.

Such risks are a form of physical risk to businesses and the financial institutions that are associated with them. They are increasingly becoming apparent due to the continuous decline in the state of nature. For example, they can arise when natural systems are compromised, due to the impact of climatic events, geologic events or changes in ecosystem equilibria, such as changes in soil quality or ocean chemistry. Changes in ecosystem condition and functioning will particularly lead to the rise of nature-related physical risks.

The materiality of risk associated with business dependencies on nature will hinge on the interaction between the level of reliance on ecosystem services (which ecosystem services the business depends upon and to what extent), and the ability of the ecosystems within which a business operates to sustain a continued flow of those services to that business. These two concepts represent the core 'pillars' of the dependency-based risk profiling methodology. Understanding this capacity for a continued flow of ecosystem services requires characterization of the ecosystem types and the condition of these ecosystems at the location of operations. This requires spatial location data. Declines in the state of nature often reduce the resilience of ecosystems and their capacity for providing ecosystem services. Importantly, only measuring the current flows of ecosystem service benefits may mean important declines in the underlying environmental assets that underpin these ecosystem service flows are missed. This means that while current risks may appear minimal, longer-term risks caused by ecosystem degradation may not be fully identified. This could lead to slow, irreversible declines in an ecosystem's capacity to provide services going undetected. For regulating and maintenance ecosystem services, in particular, it is therefore recommended to assess the condition of the ecosystem rather than the actual flows of services it currently provides.

Figure 2
Building blocks for profiling dependency-based risks.



1.1.2
Impact based risk

Risks are also faced by businesses that impact nature. Impacts are defined by the TNFD as changes in the state of nature, which may result in changes to the capacity of nature to provide social and economic functions. Businesses negatively impact nature through pressures (referred to as 'Impact Drivers' in the TNFD). Impacts can be direct, indirect or cumulative.

Considering the current developments as governments and the financial sector take action to halt and reverse decline in the state of nature, businesses that cause negative impacts on nature could face an increasing level of transition risk. These risks result from a misalignment between an organization's strategy and the landscape in which it operates. Transition risks come in various forms. For example, businesses are increasingly facing reputational risks due to changes in societal perceptions of businesses' role as it relates to nature. They are also facing increasing commercial risks due to the shifting of demand to products that are less environmentally damaging. Additionally, they may face increasing risks from technological breakthroughs, leading to substitution of products or services with fewer negative impacts on nature.

The levels of risk associated with a business' impacts on nature will be closely related to both the magnitude of impacts (the degree to which business operations apply pressures and cause a footprint on the state of nature based upon both the area occupied and the intensity of ecosystem use) and the environmental and/or societal significance of the locations impacted. These two concepts form the core pillars of the nature risk profile methodology for impacts. The magnitude of impact may be characterized broadly at the sector level. Alternatively, through adjustments for the specific pressures exerted and mitigation measures applied by individual businesses, they can be characterized at specific locations. To be assessed effectively, the significance of the environmental assets affected requires spatial location data on business activities and the specific ecosystems they are located in. Geospatial data layers can then be used to evaluate the state and irreplaceability of the environmental assets impacted.

Figure 3
Building blocks for profiling impact-based risk.

1.1.3
Feedback and future developments

The above building blocks for the methodology have benefited from extensive review by S&P Global Sustainable1's Knowledge Community as well as by key experts within the scientific and conservation community. Feedback from the consultation process has helped to inform the development of this first iteration of the methodology. This feedback is summarized in Annex 1 – Summary of feedback.

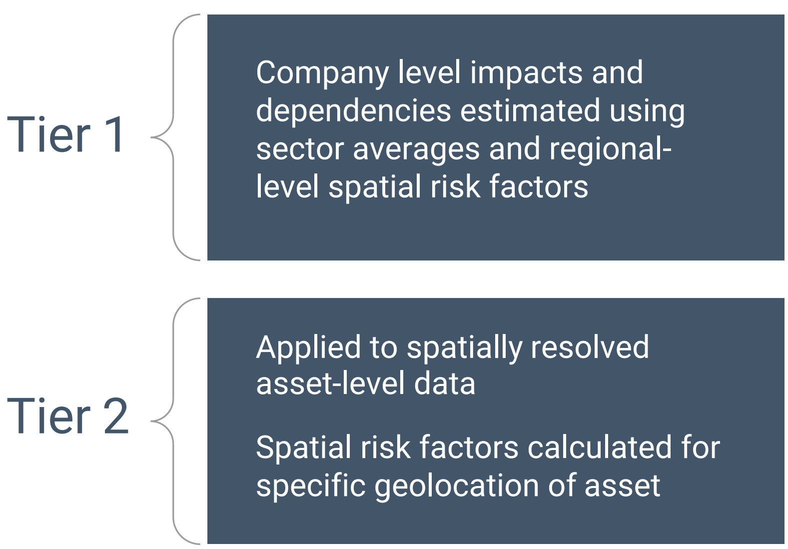
Key priorities for future developments are listed below:

1. Impacts on vulnerable groups, including diverse groups of women and girls.
While this is not included in the current version of the methodology, it is foreseen to be added in the impact component in the next iteration. This will be reliant on the availability of suitable global spatial data. Some options for consideration include data on Indigenous and Community Conserved Areas (ICCAs) and Other Effective Area-based Conservation Measures (OECMs). However, the appropriateness of these data for inclusion will be duly considered along with additional data sources through a full scoping exercise in 2023. As with other elements of the methodology, the intention will be to align with the TNFD's approach. In this instance, this will include aligning with the TNFD's thinking on gender considerations and other social elements of nature-related risk management and disclosures, which is still developing (see TNFD 2022). It will also involve aligning with the recommendations/approach of the evolving TFID (Taskforce on Inequality-related Financial Disclosures, n.d.) when it comes to integrating social impacts in the methodology.
2. Integration of value chain scores in the methodology.
The first iteration of this methodology captures direct dependencies and impacts. The next will extend to cover value chain impacts and dependencies and integrate them into the overall scoring approach. This will draw on Input-Output modelling and Life Cycle (Impact) Assessment approaches to cover upstream and downstream links respectively.
3. Capacity of ecosystems to provide regulating/maintenance ecosystem services.
The next iteration of the methodology will consider how to assess the ability of ecosystems to provide regulating and/or maintenance services in more detail. The current approach is based on a global dataset that assesses the integrity of ecosystems. While this is a good starting point, it would be ideal to assess the ability of individual ecosystem types to provide different ecosystem services. Scoping approaches to do this at the global level will be a key priority for the next iteration of the methodology.
4. Addition of risk mitigation in the methodology.
The current version of this methodology captures exposure to risk but does not fully extend this to the actions that companies may have in place to mitigate such risks. This will be a core component to add in the future, but will require company and location-specific information.
5. Coverage of freshwater and marine ecosystems.
While the methodology is suitable to assess these realms, sufficient data and techniques are still lacking to assess them to the standard suggested in this methodology for terrestrial ecosystems.

02 Methodology/approach

The methodology developed here is aimed at using input data with different levels of spatial detail, structured around two core 'tiers' (Figure 4). The most accurate and spatially precise profiles of nature-related risk exposure will be based on geolocated asset level data ('Tier 2' e.g., buffered point, polygon or line data), in line with the focus of the TNFD on understanding location-specific nature-related risks. Where asset level data is not readily available, estimates of metrics at a broader sectoral and spatial resolution can be used to estimate potential risk exposure ('Tier 1). Methods to estimate likely locations of sector activities within countries can be used to refine sectoral approaches used in Tier 1 assessments. For example, layers representing the spatial breakdown of GDP production within countries can be used to weight average impacts and spatial risk factors.

Figure 4
Tiered approach to the Nature Risk Profile methodology.



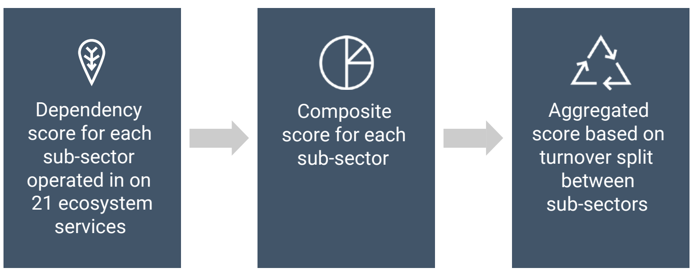
03

Dependencies methodology guidelines

3.1
Dependency scoring approach

A score at either the individual asset or business level for overall exposure to dependency-based risk is calculated by breaking-down total turnover into the different economic sectors operated in. Once this is done, scores for the materiality associated with these sectors on 21 individual ecosystem services are applied (Annex 2, Table 1). The overall process consists of three steps (Figure 5).

Figure 5
Scoring process for ecosystem service dependencies.



1. A given business or asset's dependencies on each of 21 ecosystem services is first assessed by combining scores of:

   a. The materiality of the dependency on that service (Section 3.2)

   b. The relevance of that service based on the locations operated in (Section 3.3)

   c. The resilience of the ecosystems providing the services (Section 3.4)

   These scores are combined using the following formulae:

$$Reliance\ score_i = \sqrt[n]{Materiality\ score_i * Relevance\ score_i}$$

$$Dependency\ score_i = \sqrt[n]{Reliance\ score_i * Resilience\ score_i}$$

   Where:

   - i: Ecosystem service i
   - n: Number of relevant score components for ecosystem service i
   - All 3 materiality, reliance and resilience scores range from 0 to 1

2. Once the dependency on each ecosystem service is scored, the scores of the 21 service dependencies are combined using a logarithmic function. This results in one dependency score for each sector. The assumption here is that the majority of risk stems from having high dependencies on a low number of ecosystem services and additional ecosystem service dependencies then cause incremental additional risk exposure.
   By applying a logarithmic function, this decreasing marginal contribution effect of additional ecosystem services is captured.

$$Composite\ score_j = f\left(\sum_{i=1}^{m} Dependency\ score_i\right)$$

   Where:

   - i: Ecosystem service i
   - j: Sector/process j
   - m: Number of ecosystem services

3. Company or asset-level turnover data is then used to produce an overall company-level, or asset-level dependency score, based on the distribution of turnover within different sub-sectors.

$$Aggregate\ score_k = \sum_{j=1}^{z} w_j * Composite\ score_j$$

   Where:

   - j: Sector j
   - wj: Weight of sector/asset j in company revenue
   - z: number of sectors/asset in company portfolio

3.2 Materiality of the dependency on an ecosystem service

The materiality rating component of the dependency scores are taken from the ENCORE knowledge base (Natural Capital Finance Alliance 2022). The ENCORE knowledge base assesses the links between each sector of the global economy, the ecosystem services that support their production processes and the natural capital assets that support those services.

The reliance of production processes on ecosystem services is scored through qualitative materiality ratings (Very Low to Very High) through the following criteria:

Table 1
Criteria for assigning materiality ratings

How significant is the loss of functionality in the production process if the ecosystem service is disrupted?	Limited loss of functionality: The production process can continue as is or with minor modifications.	Moderate loss of functionality: The production process can continue only with important modifications (e.g. slower production or use of substitutes).	Severe loss of functionality: Disruption in the service provision prevents the production process.
How significant is the financial loss due to the loss of functionality in the production process?	Limited financial loss: Disruption to the production process does not materially affect the business' profits.	Moderate financial loss: Disruption to the production process materially affects the company's profits.	Severe financial loss: There is a reasonable possibility that the disruption in the production process will affect the financial viability of the company.

These qualitative ratings are turned into the following quantitative scores:

Table 2
Conversions to numeric materiality scores

No dependency	0
VL	0.2
L	0.4
M	0.6
H	0.8
VH	1

For sectors comprised of more than one production process, materiality ratings for each production process are aggregated up to sector level. Where it is deemed that disruption to any of the production processes would hinder the production of the overall sub-sector, i.e. they are complementary to each other, the maximum ratings for the production processes are taken to represent the sub-sector. For sub-sectors where the production processes are mutually exclusive, the average of the ratings is taken.

3.3
Relevance of an ecosystem service based on location

The potential for benefits to be gained from many regulating services is unevenly distributed spatially and depends on the degree to which a given location is at risk from disruptions, like natural hazards, that the ecosystem service helps to regulate. For example, the potential for a benefit to be gained from flood protection services will be highest in areas of high flood risk and the potential for a benefit to be gained from water filtration services will often be highest in heavily polluted areas. Where the potential benefit of the ecosystem service is low or negligible, the relevance of the ecosystem service will also tend to be low despite a potentially high materiality rating estimated at the sector or business activity level. Consequently, for certain ecosystem services, materiality ratings should be adjusted for the potential benefit. A list of services that are likely to need adjustment for local relevance is provided in Table 1 (Annex 2 – Ecosystem services and how they are treated in the methodology).

Tier 1 – Data layers representing the need for the identified regulating services should be normalized between 0 and 1. Country level averages can then be taken and applied where asset level data is not available (this will be provided as a separate technical annex in future).

Tier 2 – Data layers representing these identified regulating services should be normalized between 0 and 1. The average of these scores can then be taken from the location of the individual asset.

3.4
Resilience of the ecosystem providing the service

The likelihood that dependency-related risks materialize depends on the capacity of ecosystems to continue to provide the necessary ecosystem services. For direct resource use, the resilience of continued supply of provisioning ecosystem services will relate directly to the continued availability of that resource within the area where operations are taking place. However, the capacity of ecosystems to provide regulating and maintenance services is more complex to measure. The links between different ecosystem variables and capacity are often unknown. This is also often true for the link between different drivers of change and ecosystem capacity. It remains important that initial scores for reliance are adjusted for the resilience of the ecosystems providing the ecosystem services. A list of ecosystem services where reliance scores should be adjusted for resilience is provided in Table 1 (Annex 2 – Ecosystem services and how they are treated in the methodology).

Given the uncertainty associated with measuring ecosystem capacity, an initial proxy for the resilience of these services is the condition of the ecosystems providing the services. Generally, more degraded ecosystems have a reduced capacity to provide services. However, it is important to emphasize that this relationship is often not linear. Ecosystem service disruption may not appear until the supporting ecosystem is nearing collapse or it may appear abruptly with only mild supporting ecosystem degradation. Additionally, ecosystems are dynamic and condition measures capture a point in time rather than trends in ongoing environmental change. The spatial scale at which services are provided is also highly variable and uncertain. As a starting point, average ecosystem condition of the ecoregion operated in can act as a proxy for the capacity of the ecoregion to provide services (this will be provided as a separate technical annex in future). While this approach may also not fully capture dependencies on individual species, such as individual pollinators, it can be built upon to consider such fine levels of detail in the future.

The Ecosystem Integrity Index is a best practice measure for providing an estimation of the condition and capacity of the ecosystems where business operations are taking place.

3.4.1
Introduction to Ecosystem Integrity Index (EII)

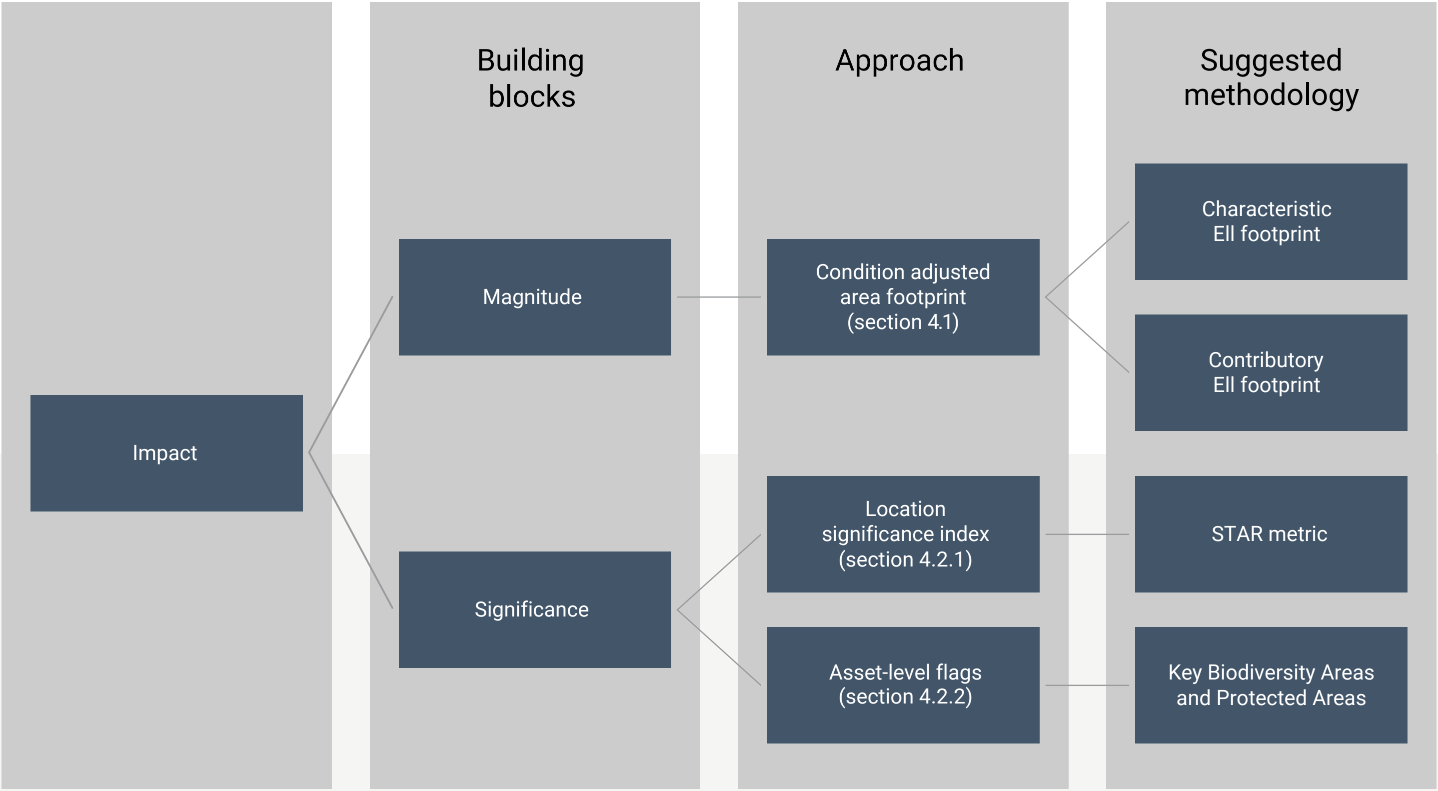
EII is a combination of geospatial layers representing the three components of ecosystem integrity. These three layers include ecosystem structure, ecosystem composition and ecosystem functioning. EII measures the extent to which ecosystems fall within a natural range of variation in their state (Carter et al. 2019). This refers to expected changes in an ecosystem's state under natural reference conditions with minimal human pressures. The index provides a simple and scientifically robust way of measuring, monitoring and reporting on ecosystem integrity at any geographical scale. The first component of EII, ecosystem structure, is designed to reflect the effect of habitat area, intactness and fragmentation. The second component, ecosystem composition, refers to the species present and the overall species diversity. The third component, ecosystem function, is defined as the core processes that occur within the ecosystem, as a result of interactions between the living and non-living components. The minimum of the three component layers is then taken to give a single aggregated metric: EII. Further description of the EII and details on the individual components are provided in Annex 3 – Description of the Ecosystem Integrity Index.

04
Impacts methodology guidelines

4.1
Impact 'footprinting' approach

Exposure to impact-related risk is calculated at either the individual asset level or the company level by estimating footprints for magnitude of impact associated with business activities and analysing the metrics for location significance where these impacts occur (Figure 6). The core approach to quantifying magnitude of impact is to calculate a footprint on ecosystem integrity, expressed as a condition-adjusted area (section 4.1.1). The significance of this footprint is then assessed through data layers that place the location of operation on a relative significance scale (section 4.2.1). At individual asset level, this approach is supplemented with additional asset level flags (section 4.2.2).

Figure 6
Impact approach within Nature Risk Profile methodology.



4.1.1
Condition adjusted area footprint (magnitude of impact)

The condition of ecosystems reflects their ability to provide ecosystem services, support viable species populations and adapt to future environmental change. Translating how the ecosystem use associated with business operations reduces ecosystem condition indicates the degree to which operations are pushing ecosystems towards tipping points. These tipping points can be either at a local level (where ecosystems fundamentally change in their capacity to supply ecosystem services) or they can be at a global level (where they contribute to large scale systemic risks).

A common metric for assessing impacts at the ecosystem level is 'condition adjusted area' (United Nations et al. 2021; Endangered Wildlife Trust 2020). Measuring the condition adjusted area involves quantifying the extent of ecosystem coverage in an area of interest and then reducing this total extent by a factor representing its condition compared to an 'intact' reference state. The concept behind this is that although there may be '100 hectares' of forest within a landscape, if the condition is only half that of an intact primary forest, then it is equivalent to having only 50 hectares of intact forest within that landscape in terms of biodiversity value.

The impact of a given business activity can be expressed in a similar way, in terms of the reduction in condition-adjusted area of an ecosystem caused by the activity. The total area of land occupied by a business activity can be adjusted for the degree to which condition is reduced, thereby expressing impact of different business activities on a common scale. This provides a measure of the equivalent area where condition is reduced to zero, calculated using the below formula:

*Footprint (Condition adjusted area) = Area * (1-remaining condition)*

Condition of ecosystems can be measured in many ways and at different scales. At the portfolio scale, it can be challenging to assess the condition of individual ecosystem types. Instead, pressure-based modelling approaches can be used to infer remaining condition at specific locations. These approaches effectively ignore the specific ecosystem types that are present and the results of these models can be input into the calculation of the integrity-adjusted area footprint. There are multiple different metrics that describe condition based on models. The Ecosystem Integrity Index below is presented here as a best practice metric for calculating the 'remaining condition' element of the footprint calculation.

4.1.2
Applying the Ecosystem Integrity Index to estimate footprint

As described in section 3.4.1, the Ecosystem Integrity Index characterizes the integrity of ecosystem structure, composition and function. It provides a robust and comprehensive multiplier of condition that can be used within condition-adjusted area metrics and to estimate the impact of company activities. There are two core methodology options for calculating the EII coefficient to apply, a 'characteristic EII' and a 'contributory' EII. The contributory method applies only to asset level data and is more computationally intensive but provides a more accurate and more interpretable footprint.

Characteristic approach

This option for the methodology estimates the total reduction in EII at a specific location compared to an 'intact' reference state (condition = 1). Taking the average EII values over a specific location 'characterizes' the average integrity of ecosystems within that area. It captures the impact of all pressures at that location, even if they are not directly associated with the business activity of interest. This provides an estimate of the overall resulting or current state of EII at the location that can be used to track progress. Further details on calculating the characteristic EII for assets and company level data are provided in Annex 4 – Methodology details for calculating footprint on EII.

Tier 1 – The average EII values over broad-scale land use classes can be averaged for each country (this will be provided as a separate technical annex in future). These can then be linked to relevant sectors to provide a relevant EII multiplier to be used to estimate a footprint of the total land use associated with that sector.

Tier 2 – To estimate the characteristic EII of assets, asset data first can be input into the composition and structural layers. This is suggested as best practice as it ensures assets of interest are contributing to the total reduction in intactness at their locations. Once layers are updated with asset level data as needed, average EII values under a specific asset polygon can be taken to provide a multiplier. This can then be combined with the area of the polygon to calculate the condition-adjusted area footprint.

Contributory approach

This methodology option is designed to assess the contributory impact, or marginal effect, of assets on ecosystem integrity. The method aims to quantify the impact of a single or specific set of assets that is additional to other pressures and the existing levels of degradation at the same location and within the surrounding landscape. This methodology therefore differs from the 'characteristic' methodology in that it draws out the specific contribution of the asset to the total EII value and therefore is not comparing the impact to an 'intact' reference state of 1. It allows an understanding of the potential improvement in overall EII should the pressures associated with the asset be removed from the landscape Each of the three ecosystem integrity components need to be manipulated separately to model these asset-level effects. Further details on the 'contributory' methodology are provided in Annex 4 – Methodology details for calculating footprint on EII.

4.2
Location significance

4.2.1
Location significance index

A limitation of only looking at the magnitude of impacts through footprinting approaches is that the relative significance of the ecosystems impacted is not fully taken into account. Areas that hold important stocks of environmental assets, such as biodiversity, water and soil, may hold elevated significance for nature-related risks. Similarly, areas integral to the continued supply of ecosystem services at a range of scales are important both from the perspective of a company and the perspective of other groups who rely on those services (including and especially women and girls, Indigenous Peoples, local communities and other stakeholders that are considered vulnerable).

There are multiple dimensions to nature significance. These reflect the multiple components of natural capital, the multiple values and benefits it provides and the multiple dimensions of nature-related risks. Risks may be elevated if a company's footprint occurs in these areas of high significance or if it occurs in areas where the species or ecosystems are deemed irreplaceable if lost at that location.

Within the methodology, significance is assessed at the global level using data layers that are standardised so that values in each location represent a proportion of high significance value globally for that variable. Data layers can be standardised between 0 and 1 so that pixels with a value of '1' represent the highest significance areas for that variable and values below are a proportion of that maximum significance. Data layers of multiple variables can be stacked together and the highest value for each pixel can be taken as the significance value to capture the significance of multiple factors.

This 'significance index' approach allows interpretation of impacts in terms of their relative location significance. It is recommended that best available data on multiple aspects of biodiversity and the provision of ecosystem services is applied as best practice. A methodology for species extinction risk, and ecosystem service provision, is provided below as an example.

Importance for Threatened species– The Species Threat Abatement and Restoration (STAR) metric

The STAR metric quantifies the potential opportunity for reducing global species extinction risk by reducing threats in specific locations (Mair et al. 2021). Individual species are given a score based upon their threat status and this score is then distributed across the range of the species. High STAR scores are found in areas with high richness of range restricted Threatened species. Reducing identified threats in these locations will have a high contribution to reducing species' global extinction risk. Failure to do so represents a high opportunity cost and contributes disproportionately to driving species to extinction.

Importance for ecosystem service provision – Critical Natural Assets

Critical Natural Assets, as defined by Chaplin-Kramer et al. (2022), represent areas that are integral to securing 90% of current levels of ecosystem service provision. Critical Natural Assets are defined separately for global ecosystem service provision (e.g. carbon sequestration) and local ecosystem service provision (e.g. pollination). Within global layers presented in Chaplin-Kramer et al (2022), the highest pixel scores are found in areas that would need to be protected to secure the top 5% of current levels of ecosystem service provision. Each subsequent score represents areas providing the next 5% of ecosystem services, down to the lowest pixel scores which are found in areas that only need to be protected if a target is to secure 100% of current ecosystem service provision.

4.2.2
A combined 'headline' impact indicator – highest significance area footprint

For certain use cases it may be required to create a single index that combines magnitude and significance into a single footprint. Combining metrics in this way reduces the interpretability of the individual scores but can provide a high-level footprint for comparing companies across sectors and geographies. It can also guide to where more detailed interpretation of the underlying metrics is most required.

The metric for 'magnitude of impact', condition adjusted area footprint, places two aspects of magnitude of impact (the area of land impacted and the degree to which integrity is reduced) into a single combined score for comparison. By further weighting this value for the value of the significance index described above, this condition-adjusted area footprint can be expressed as a footprint of 'highest significance' area. Importantly, this metric is not a physical area to be managed, but a useful conceptual way of comparing impact that considers the relative footprints of different activities/companies as if they were all operating in the highest significance areas globally.

*Highest significance area footprint (equivalent ha) = Magnitude (Condition adjusted area) * Significance (location significance index)*

4.2.3
Asset-level significance flags

In addition to global data layers that provide a scale of relative location significance, asset level data can be assessed for significance by overlaying them with area-based data layers defining areas of high significance. In contrast to the continuous 'significance index' approach described above, these provide additional binary contextual flags as to the significance of the location of the assets and the associated asset-level impacts. It is recommended that these additional asset level flags are included as best practice. Although many different area-based designations exist, which reflect a range of regulatory and reputational risks at a range of scales, two global standard datasets are recommended as detailed below. In the future, these can be complemented with other relevant datasets that become available.

World Database of Key Biodiversity Areas

Key Biodiversity Areas (KBAs) are sites contributing significantly to the global persistence of biodiversity (International Union for Conservation of Nature [IUCN] 2016). KBAs are identified at the national, sub-national or regional level by local stakeholders based on standardised scientific criteria and thresholds. Operating within KBAs poses a series of potential transition risks for businesses. They are also featured in major standards such the International Finance Corporation's Performance Standard 6 on Biodiversity Conservation and Sustainable Management of Living Natural Resources (International Finance Corporation 2012). The World Database of Key Biodiversity Areas is curated by BirdLife International on behalf of the KBA partnership and made available for commercial use via the Integrated Biodiversity Assessment Tool (IBAT).

World Database on Protected Areas

A protected area is "a clearly defined geographical space, recognized, dedicated and managed through legal or other effective means to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley 2008). Protected areas are the cornerstones of in-situ conservation. They are also featured in major standards, including the Global Reporting Initiative Standards (GRI 304) and the International Finance Corporation Performance Standard 6. Certain types of protected areas allow economic production to occur within their boundaries, however, they should always be approached with caution and any negative impacts on these areas should be avoided.

05
Conclusion

The methodology that we have outlined here provides a set of core measurements that support the ‘Locate’ and ‘Evaluate’ step of the TNFD’s ‘LEAP’ approach (Locate, Evaluate, Assess and Prepare to disclose). These measurements of dependencies and impacts facilitate the assessment of associated risks and opportunities. Future developments of the methodology aim to increase focus on impacts on Indigenous Peoples and Local Communities, as well as expanding to cover freshwater and marine realms. In developing and sharing this open access methodology, we hope to support the TNFD in implementing a common and harmonized approach to nature-related risk management within the finance sector. In turn, this approach can support the halting and reversal of the global decline in nature that we are facing.

Conclusion

Table 3. Alignment of the proposed methodology with the TNFD's 'LEAP' approach

	Dependencies on nature					Impacts on nature				
Nature Risk Profile - Methodology building block	Reliance on ecosystem services		Resilience of ecosystem services		Risk mitigation	Magnitude of potential impact		Significance of potential impact		Risk mitigation
	Materiality of reliance of ecosystem services	Relevance of ecosystem services provision	Supply of provisioning ecosystem services	Capacity of ecosystems to provide regulating and maintenance services	Mitigation strategy and measurement	Ecosystem footprint	Potential reduction in ecosystem integrity	Irreplaceability of environmental assets and ecosystems	Regulatory and public significance of area impacts	Mitigation strategy and measurement
TNFD - Locate	L4 Sector identification		L3 Priority location identification	L3 Priority location identification		L1 Business footprint	L2 Nature interface		L3 Priority location identification	
TNFD - Evaluate	E2 ID of dependencies	E3 Dependency analysis	E3 Dependency analysis	E3 Dependency analysis		E2 ID of impacts	E4 Impact analysis			
TNFD - Assess		A1 Risk and opportunities ID*			A2, A3, A4 Risk mitigation, management and assessment *		A1 Risk and opportunities ID*	A1 Risk and opportunities ID*	A1 Risk and opportunities ID*	A2, A3, A4 Risk mitigation, management and assessment*
TNFD - Prepare	Potentially all of the above depending on assessment phase									

* Partial alignment. The assess phase will be covered in full in further iteration of the methodology

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References

Beyer, H.L., Venter, O., Grantham, H.S. and Watson, J.E.. (2020). Substantial losses in ecoregion intactness highlight urgency of globally coordinated action. Conservation Letters, 13(2), e12692.

Carter, S.K., Fleishman, E., Leinwand, I.I., Flather, C.H., Carr, N.B., Fogarty, F.A.et al. (2019). Quantifying ecological integrity of terrestrial systems to inform management of multiple-use public lands in the United States. Environmental management, 64(1), 1-19.

Chaplin-Kramer, R., Neugarten, R.A., Sharp, R.P., Collins, P.M., Polasky, S., Hole, D et al. (2022). Mapping the planet's critical natural assets. Nature Ecology & Evolution, 1-11.

Dasgupta, P. (2021). The Economics of Biodiversity. The Dasgupta Review. Available at: https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review

Dudley, N. (2008). Guidelines forapplying protected area management categories. IUCN, Gland, Switzerland. Available at: https://portals.iucn.org/library/sites/library/files/documents/pag-021.pdf

Endangered Wildlife Trust (2020). The Biological Diversity Protocol (BD Protocol). National Biodiversity and Business Network - South Africa, 123p. Available at: https://nbbnbdp.org/biodiversity-protocol/

Hill, S.L., Arnell, A., Maney, C., Butchart, S.H., Hilton-Taylor, C., Ciciarelli, C. et al. . (2019). Measuring forest biodiversity status and changes globally. Frontiers in Forests and Global Change, 2, 70.

Hudson, L.N., Newbold, T., Contu, S., Hill, S.L., Lysenko, I., De Palma, A et al. (2017). The database of the PREDICTS (projecting responses of ecological diversity in changing terrestrial systems) project. Ecology and evolution, 7(1), pp.145-188.

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services on the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. S. Díaz, J. Settele, E. S. Brondízio E.S., H. T. Ngo, M.G., J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S.M.S., G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A. Pfaff, S. Polasky, A. Purvis, J. Razzaque, B. Reyers, R. Roy Chowdhury, Y.J.S. and I. J. Visseren-Hamakers, K. J. Willis, and C.N.Z. (Eds.). IPBES Secretariat, Bonn, Germany. 56 pp.

International Finance Corporation (2012). Biodiversity Conservation and Sustainable Management of Living Natural Resources. Available from: https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/performance-standards/ps6

International Union for Conservation of Nature (2016). A Global Standard for the Identification of Key Biodiversity Areas, Version 1.0. First edition. Gland, Switzerland: IUCN. Available from: https://portals.iucn.org/library/node/46259

Kennedy, C.M., Oakleaf, J.R., Theobald, D.M., Baruch-Mordo, S. and Kiesecker, J. (2019). Managing the middle: A shift in conservation priorities based on the global human modification gradient. Global Change Biology, 25(3), 811-826.

Mair, L., Bennun, L.A., Brooks, T.M., Butchart, S.H., Bolam, F.C., Burgess, N.D. et al. (2021). A metric for spatially explicit contributions to science-based species targets. Nature Ecology & Evolution 5, 836–844. Available at: https://doi.org/10.1038/s41559-021-01432-0.

Natural Capital Finance Alliance (Global Canopy, UNEP FI, and UNEP-WCMC) (2022). ENCORE: Exploring Natural Capital Opportunities, Risks and Exposure. [On-line], Cambridge, UK: the Natural Capital Finance Alliance. Available at: https://encore.naturalcapital.finance. DOI: https://doi.org/10.34892/dz3x-y059.

Newbold, T., Hudson, L.N., Arnell, A.P., Contu, S., De Palma, A., Ferrier, S. et al.(2016). Has land use pushed terrestrial biodiversity beyond the planetary boundary? A global assessment. Science, 353(6296), 288-291.

Running, S. W., and Zhao, M. (2019). Daily GPP and Annual NPP (MOD17A2H/A3H) and Year-End Gap- Filled (MOD17A2HGF/A3HGF) Products NASA Earth Observing System MODIS Land Algorithm (For Collection 6), MODIS Land Team, Version 4.2, pp.35.

Taskforce on Inequality-related Financial Disclosures n.d. Available at: https://thetifd.org/

Taskforce on Nature-related Financial Disclosures (2022). Societal dimensions of nature-related risk management and disclosure: Considerations for the TNFD framework. Available at: https://framework.tnfd.global/wp-content/uploads/2022/11/TNFD_Societal_Dimensions_Discussion_Paper_v0-3_C.pdf

United Nations et al. (2021). System of Environmental-Economic Accounting — Ecosystem Accounting (SEEA EA). White cover publication, pre-edited text subject to official editing. Available at: https://seea.un.org/ecosystem-accounting.

The United Nations Entity for Gender Equality and the Empowerment of Women (2018). "Turning promises into action: gender equality in the 2030 agenda for sustainable development". Available at: https://www.unwomen.org/en/digital-library/publications/2018/2/gender-equality-in-the2030-agenda-for-sustainable-development-2018.

World Economic Forum and PricewaterhouseCoopers (2020). Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy. Available at: https://www.weforum.org/reports/nature-risk-rising-why-the-crisis-engulfing-nature-matters-for-business-and-the-economy.

07
Annexes

Annex 1
Summary of feedback

The following table provides a summary of the feedback collected through S&P Global Sustainable1's Knowledge Community, which was set up for the purpose of developing this methodology . The consultation was two-pronged, involving: 1) calls with individual organisations to gather qualitative feedback; and 2) a survey to gather both quantitative and qualitative feedback. Overall, 28 organisations directly engaged in the consultation.

Table 4. Summary of feedback received and response within the methodology

Feedback	Response in methodology
Several respondents asked questions that should be answered during and after the development of the methodology. These included concerns that references to "nature" are too broad and ideally need explicit definition, and requests to better outline the purpose of the methodology.	The methodology defines nature in line with the definition adopted by the TNFD (see Glossary of Key Terms). The purpose of the methodology is outlined in the introduction. It aims to provide a practical way to implement the TNFD's framework by giving businesses and financial institutions a method to assess nature-related dependencies and impacts.
Numerous contributors wanted to learn more about how the methodology would cover the issue of double materiality.	The methodology will evolve to fully capture double materiality. The first version to be released captures both dependencies and impacts on nature, thus quantifying nature-related risk and capturing the relationship between nature's potential impact on a business and vice versa. In future, this will be expanded to capture risks of impacting stakeholders (e.g. women, girls, Indigenous Peoples and Local Communities). Additionally, it is expected to translate nature risk into financial risk for businesses and financial institutions.
There was a request to provide an illustrative example of the methodology's application, and possibly a case study for each major industry; something that can be easily incorporated after pilots have been completed. An illustrative example would also help to cut through some of the more technical nature concepts.	Examples of workflows for businesses are provided in this methodology document. Further case studies will be developed following testing of the initial version of the methodology.
Sector and sub-sector specificity was a significant concern for respondents, with suggestions for sector-specific guidance as dependencies can vary significantly even within a sector. Conversely, some sectors are critical for biodiversity and should be identified as such: this could be reflected in the choice of key sectors, which one respondent noted had not yet been identified. This attention to sector application extended to interest in whether sector-specific indicators exist. Other respondents questioned whether the current methodology is applicable to financial industries.	The methodology captures differences between sectors' and sub-sectors' dependencies and impacts on nature. For example, for dependencies, each sub-sector has its own 'profile' of dependencies (i.e., the set of ecosystem services it typically depends on), which is then complemented by spatially explicit information on the relevance and resilience of ecosystem services. As far as possible, the indicators used are applicable across all sectors to enable comparability.
Many highlighted the length of financial supply chains and emphasised considering impacts and dependencies both upstream and downstream, as well as the size of portfolios, representing a diverse breadth of investment types (equity/debt/etc.).	The first version of the methodology captures direct dependencies and impacts. However, through use of Input-Output modelling and Life Cycle (Impact) Assessment approaches it can be extended to cover upstream and downstream dependencies and impacts.
One respondent from academia argued that in any aggregation, high risk flags should always carry through and not be averaged out. This echoed other queries as to how risk would be handled in the methodology: some measure of likelihood would be appreciated, and possibly the inclusion of risk mitigation failure tracking.	This is covered in the headline impact indicator approach as well as through the retention of asset-level significance flags.
Several respondents flagged that including opportunities, as well as risks, might be beneficial for users.	The methodology currently focuses on nature related risks. Feasibility of including nature related opportunities will be explored in future versions, in line with development of the TNFD's approach to opportunities.

Annex 2

Ecosystem services and how they are treated in the methodology

Table 5. Approach for treatment of ecosystem services in the dependencies methodology

Ecosystem service	Sub-category	Materiality	Adjust for relevance?	Adjust for resilience?
Animal-based energy	Provisioning services	Yes	No	No
Fibres and other materials	Provisioning services	Yes	No	No
Genetic materials	Provisioning services	Yes	No	No
Ground water	Provisioning services	Yes	No	Yes
Surface water	Provisioning services	Yes	No	Yes
Bio-remediation	Regulatory & maintenance services	Yes	No	Yes
Buffering and attenuation of mass flows	Regulatory & maintenance services	Yes	Yes	Yes
Climate regulation	Regulatory & maintenance services	Yes	No	Yes
Dilution by atmosphere and ecosystems	Regulatory & maintenance services	Yes	No	Yes
Disease control	Regulatory & maintenance services	Yes	No	No
Filtration	Regulatory & maintenance services	Yes	No	Yes
Flood and storm protection	Regulatory & maintenance services	Yes	Yes	Yes
Maintain nursery habitats	Regulatory & maintenance services	Yes	No	Yes
Mass stabilisation and erosion control	Regulatory & maintenance services	Yes	Yes	Yes
Mediation of sensory impacts	Regulatory & maintenance services	Yes	No	Yes
Pest control	Regulatory & maintenance services	Yes	No	Yes
Pollination	Regulatory & maintenance services	Yes	No	Yes
Soil quality	Regulatory & maintenance services	Yes	No	Yes
Ventilation	Regulatory & maintenance services	Yes	No	No
Water flow maintenance	Regulatory & maintenance services	Yes	No	Yes
Water quality	Regulatory & maintenance services	Yes	No	Yes

Annex 3

Description of the Ecosystem Integrity Index

A detailed description of the Ecosystem Integrity Index is provided in Hill et al. (2022). A summary of the layer descriptions provided in Hill et al (2022) is provided below.

Structure

The metric is derived from a total of 11 biodiversity pressure layers including population density, built-up areas, agriculture, roads, railroads, mining, oil wells, wind turbines and electrical infrastructure. These pressure layers are aggregated using the methodology described in the Human Modification Index to produce a single pressure index (Kennedy et al. 2019). This index is transformed using the methods described in Beyer et al. (2019) so that it can account for the influence of habitat loss, quality and fragmentation. The final structural layer that is produced thus captures effects of land use at the landscape level as well as describing local intactness. This feature of EII is a distinct advantage over other condition metrics, which often focus on impact at local levels, without the context of the wider landscape.

Composition

The metric chosen for this layer is the Biodiversity Intactness Index (BII), which summarizes change in the make-up of ecological communities in response to human pressures (Newbold et al. 2016; Hill et al. 2019). The BII is calculated using two models estimated using data taken from the PREDICTS database (Hudson et al. 2017). The first assesses the impact of human pressures on the total abundance of species within a community and the second analyses the similarity between the relative abundance of each of the species in a community in a non-natural landscape with those in a natural landscape. The product of the two models, projected onto maps of human pressures, results in the BII.

Function

The functioning component is estimated using the difference between potential natural and current net primary productivity (NPP) within each 1km2 grid cell. The functioning component is a metric which describes the ratio between observed net primary productivity (NPP) and ecoregion 'natural' reference NPP levels. Current NPP is derived from remote sensed geospatial layers (Running and Zhao 2019). The natural, potential NPP layer is modelled using environmental input data including temperature, precipitation, landforms, and soil types.

Aggregated EII

The three component layers are then aggregated to give a single metric: EII. A minimum value approach is employed, whereby the value per grid cell is taken from the lowest scoring of structure, composition and functioning. This method was chosen with the reasoning that the integrity of an ecosystem is limited and determined by minimum score from any of the three contributing layers.

Annex 4
Methodology details for calculating footprint on EII

Characteristic methodology

Before calculating the characteristic methodology, asset data should be inputted into the structure and composition layers, to ensure that the assets of interest are contributing to the total EII value in their locations.

For the structural integrity layer, the layer is calculated using 11 different biodiversity pressure layers, Layers within this metric are interchangeable with company asset-level data, which will often have a much greater level of accuracy and higher granularity than the global layers.

For the composition layer, simulating the impact of assets on ecosystem composition requires the projection of new model coefficients within areas of impact. The composition layer is a modelled relationship between the Biodiversity Intactness Index, land use and a set of continuous pressure variables, such a human population density, projected onto land use maps. It is modelled from site-level data within the PREDICTS database, which has few studies of biodiversity within site-based sectors such as mines or oil and gas infrastructure. An assessment of land use classes shows that secondary vegetation (intense use) is the most appropriate coefficient to apply to areas where vegetation is likely to be cleared for the activity, such as mining. The asset level data layer is overlaid on to composition layer and where polygons occur, the secondary vegetation intense use coefficient is projected. Mean BII is then calculated within the asset footprint.

Contributory methodology

Of the three contributory ‘footprints’ described below, the largest is taken as the overall contributory footprint on EII.

Structure

Once the company data is inputted as described above, 10km buffer zones are added around asset polygons. Structural integrity calculations are made within these buffer areas to assess the impact of the asset on the wider landscape.

To determine the contributory impact of specific assets, company data layer from the index is removed entirely, calculating a structural integrity score with the remaining biodiversity pressure layers. This provides an integrity score representative of the landscape without the existence of company assets.

From this score, we can subtract the score calculated when company asset-level data is incorporated and derive the change in structural integrity attributed to the asset. The sum of pixels within a 10km buffer then represents the structural footprint.

One issue that could arise with this methodology is the occurrence of multiple assets within the 10km buffer. Due to the nature of the index and the influence of the landscape on values within the asset footprint, this could overestimate the impact of single assets, because of their proximity to others. A modification can be employed in these situations, where single polygons can be dropped one at a time and scores calculated in each instance. As all other assets remain constant in this process, the contributory impact of that one asset can be determined.

Composition

To assess the contributory impact of a specific set of assets they need to be ‘removed’ to get an estimate of ecosystem composition within their footprint, prior to their existence. Where assets occur, the mean BII in the absence of the asset is calculated, and from this BII with the asset present subtracted. This gives the difference in mean BII and thus the contributory impact on ecosystem composition of the assets in question. This value is multiplied by the area of the mine to give an EII footprint.

This methodology does not account for the fact that other land uses may appear following the establishment of site-based assets such as mines. This is often the case where infrastructure developments tend to be the catalyst for conversion of surrounding localities. Understanding the chronology of land use change can therefore aid in interpreting the contributory impact.

Function

Compared to structural and compositional integrity, the intactness of functioning is based on remote sensed data, rather than modelled levels of intactness based on pressures. It is therefore not possible to model intactness with and without the presence of a given asset. It is recommended that the average EII value directly outside the boundaries of a given asset is used to characterise baseline levels of functioning intactness at that location. From this the footprint on functioning of the asset is subtracted to estimate a contributory impact.

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