Sustainable1

# Nature & Biodiversity Risk

## Methodology

**Sustainable 1 – April 2024**

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# Introduction: The Nature Risk Profile

**Context**

The methodology presented in this document underpins S&P Global Sustainable1's Nature & Biodiversity Risk dataset that helps companies and financial institutions profile nature-related risks associated with location-specific business activities. It is a first iteration that draws heavily on the principles outlined by the Taskforce on Nature-related Financial Disclosures (TNFD) in its Beta framework, and the Nature Risk Profile methodology launched by S&P Global Sustainable1 and UNEP in January 2023. It allows reporting entities to respond to the recommendations of the TNFD by supporting implementation of its framework. It can draw on both disclosed and third-party company provided data. The methodology rests on two core building blocks for profiling nature-related risks; dependencies on nature; and impacts on nature. These are broken down into components that profile nature-related risks that can be assessed using company data and global nature-related datasets. The methodology can be applied at the asset, company, and portfolio level.

> 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 refers to how nature may impact an organization's immediate financial performance (outside-in) and how an organization impacts nature, and the consequences for both business and society (inside out). In other words, businesses need to consider how nature loss, due to their own activities or those of others, may not only negatively affect their own business 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).

**Key features**

- Robust, science-based, and open-source nature risk assessment methodology, developed in partnership with the UNEP World Conservation Monitoring Centre (UNEP-WCMC)[1]
- Coverage of impacts to terrestrial ecosystems using best-available geospatial metrics and datasets
- Coverage of dependency risks across 21 ecosystem services, leveraging location-specific assessments
- Coverage of proximity to Protected Areas and Key Biodiversity Areas, in line with regulatory requirements and voluntary guidelines
- Built upon a proprietary database of over 1.6 million assets linked to corporate entities and ultimate parent entities - based on S&P Market Intelligence, S&P Commodity Insights, and

[1] UNEP-WCMC – S&P Global: Nature Risk Profile: A methodology for profiling nature related dependencies and impacts

https://www.spglobal.com/esg/solutions/nature-risk-profile-methodology.pdf

S&P Global Sustainable1 datasets - and with flexibility to rapidly analyze client provided asset information.

- Nature and biodiversity risk analytics for over 20,000 companies representing over 98% of global market capitalization[2], ensuring high levels of coverage for equity and fixed income portfolios across all markets.

[2] Based on S&P Global DJI BMI Index as of 30th September 2023.

# Definitions, Scope, and General Approach

**Definition of nature and the concept of ecosystem integrity**

1. Nature, ecosystems, and biodiversity

The TNFD defines nature, or environmental assets, as the naturally occurring living and non-living components of the Earth, for example, forests, wetlands, coral reefs, and agricultural areas. Ecosystems are an important part of these assets, and the TNFD defines them as a dynamic complex of plants, animals, and microorganisms, interacting with each other and their non-living environment. They support the provision of ecosystem services, which deliver benefits (the goods and services that are ultimately used by people and society) to business.

Biodiversity is an essential characteristic of nature that is critical to maintaining the quality, resilience and quantity of ecosystem assets and the provision of ecosystem services that business and society rely upon.

Following this logic, S&P Global Sustainable1 defines nature as ecosystems and provide metrics to measure the impact of businesses on ecosystems, as well as the dependencies of business to the services provided by these ecosystems.

2. Ecosystem integrity

The TNFD recommends a set or dashboard of metrics that measure the status (and importance) of ecosystems:

- The extent – the area coverage of a particular ecosystem, usually measured in terms of spatial area.
- Condition (health) – measures of the quality of ecosystems relative to a pre-determined reference condition. Biodiversity is integral to measuring ecosystem condition, contributing to the composition, structure, and function of ecosystems.

A reference condition is the condition against which past, present, and future ecosystem condition is compared in order to measure relative change over time. One reference condition[3]

[3] A reference state commonly used in measurement approaches is 'pristine' nature, which is a comparison relative to the natural state. An alternative is a counterfactual reference state which takes a plausible state if the business did not operate, taking into account external impacts such as climate change. CDSB (2021) Biodiversity Application guidance

could be a previous or desired state of nature that can be used for comparison[4]. The choice of reference condition will depend on the business and environmental context. In this approach, it is defined as a pristine/undisturbed condition.

This methodology uses the concept of ecosystem integrity, which measures the condition of ecosystems based on the three components: structure, composition, and function, in line with the TNFD recommendations.

Ecosystem integrity encompasses the full complexity of an ecosystem, including the physical, biological, and functional components, together with their interactions, and measures these against a 'natural' (i.e., current potential) reference level. Ecosystem integrity is fundamental to the stability of Earth systems on which humanity depends. For instance, natural areas containing ecosystems with higher integrity have greater potential to provide services such as carbon sequestration, maintenance of water quality, climate regulation, pest control, and pollination – as well as supporting higher levels of biodiversity.[3]

## 3. Ecosystem Integrity Index

The methodology uses a novel index that represents, in one combined metric, the integrity of terrestrial ecosystems globally at 1km2 resolution: the Ecosystem Integrity Index (or "EII"). The index provides a simple, yet scientifically robust way of measuring, monitoring, and reporting on ecosystem integrity at any geographical scale. It is formed of three components: structure, composition, and function, and is measured against a natural (current potential) baseline on a scale of 0 to 1. The index has been developed to help national governments measure and report on the goals and targets being developed within the draft post-2020 global biodiversity framework being negotiated under the Convention on Biological Diversity, and for non-state actor contributions to also be recognized.[5]

The three components of structure, composition, and function represent critical features of ecosystem integrity:

- **Ecosystem structure** encompasses habitat intactness. It is reduced by activities that cause fragmentation in previously interconnected ecosystems, such as building roads or power lines through pristine natural environments.

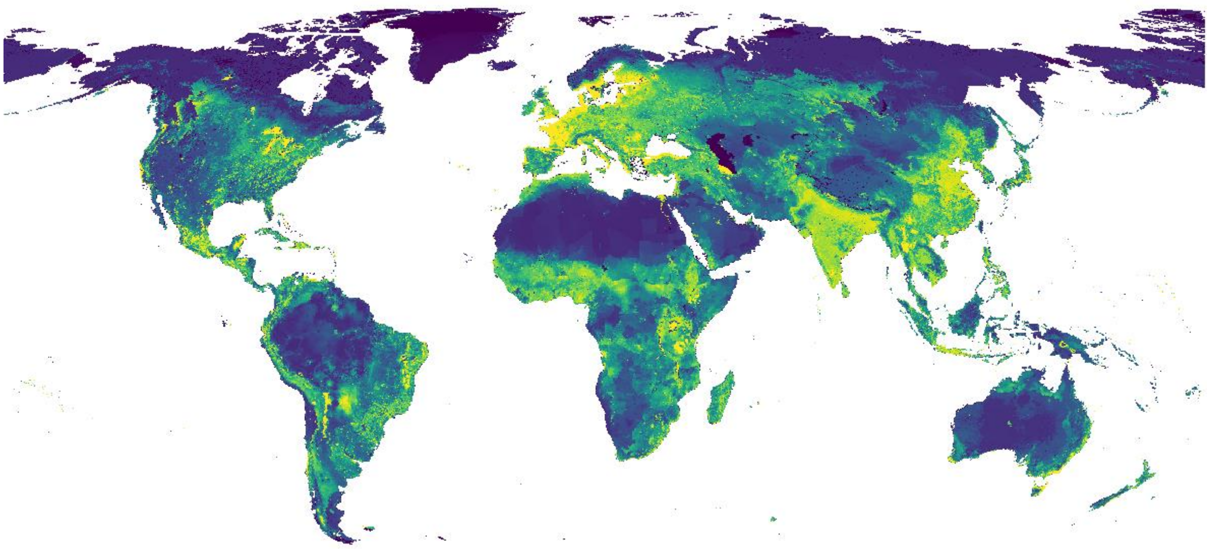
- **Ecosystem composition** considers the variety and abundance of species. It is reduced by activities that threaten the diversity or abundance of species in an area.

[4] UNEP-WCMC, Capitals Coalition, Arcadis and ICF (2022) Recommendations for a standard on biodiversity measurement and valuation. Consultation Draft. Aligning Accounting Approaches for Nature (Align)

[5] Samantha L.L. Hill, Javier Fajardo, Calum Maney, Mike Harfoot, Michelle Harrison, Daniela Guaras, Matt Jones, Maria Julia Oliva, Fiona Danks, Jonathan Hughes, Neil D. Burgess (2022) The Ecosystem Integrity Index: a novel measure of terrestrial ecosystem integrity with global coverage

- **Ecosystem function** captures the contribution of ecosystems, notably the contribution of vegetation to net carbon gain via net primary productivity. It is reduced in areas of high deforestation. A more detailed description of the index, including its individual components, can be found in Appendix 1.

***Figure 1: Ecosystem Integrity Index***



Source: UNEP WCMC, S&P Global Sustainable1

Darker blue shades indicate pristine areas, while lighter yellow shades indicate highly degraded areas.

Source: Samantha L.L. Hill, Javier Fajardo, Calum Maney, Mike Harfoot, Michelle Harrison, Daniela Guaras, Matt Jones, Maria Julia Oliva, Fiona Danks, Jonathan Hughes, Neil D. Burgess (2022) The Ecosystem Integrity Index: a novel measure of terrestrial ecosystem integrity with global coverage

**Scope**

1. Operations

The data and metrics provided in the S&P Global Nature & Biodiversity dataset cover the direct operations of companies in the S&P Global Sustainable1's Core Plus Universe. The coverage of the dataset across the Core Plus Universe is 20,277 companies as of October 2023. While impacts and dependencies embedded in supply chains are material, they are not yet covered in this dataset.

2. Realms

While the TNFD identifies four realms (land, water, ocean, and atmosphere), the current dataset covers impacts on terrestrial ecosystems only, and dependencies on terrestrial and freshwater ecosystem services.

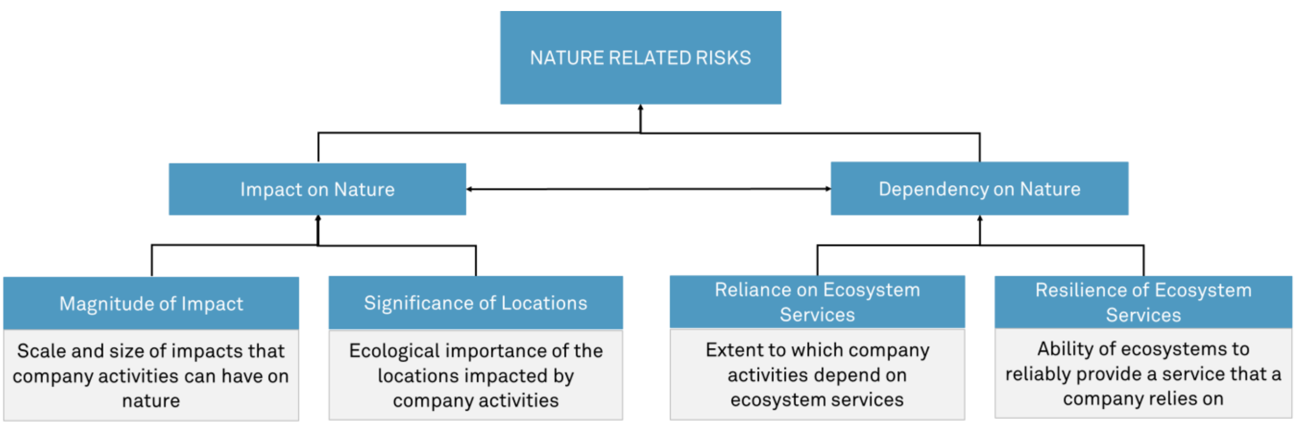
## General approach

The methodology presented in the following sections rests on two core building blocks for profiling nature-related risks; dependencies on nature; and impacts on nature.

The approach is aligned with the general objectives of the TNFD, whereby:

- Companies should assess their impact on the integrity of ecosystem (magnitude) and the importance of these ecosystems (significance)
- Companies should assess their dependency risk, defined as the combination of exposure (reliance) to and likelihood of risks (resilience risk)

*Figure 2: Key elements forming the building blocks of the methodology for profiling nature-related risks*




Source: UNEP-WCMC – S&P Global: Nature Risk Profile: A methodology for profiling nature related dependencies and impacts. https://www.spglobal.com/esg/solutions/nature-risk-profile-methodology.pdf

Readers should note that a company can have an impact on nature that other groups depend upon and impact on the nature that it depends on for its own activities. This is represented Figure 2 by the double arrow between impacts on nature and dependencies on nature.

*Table 1: Key questions answered by the main building blocks indicators*

| Indicator | Question answered |
|---|---|
| Magnitude of impact | What is the scale and size of the impacts that company activities can have on nature? |

| | |
|---|---|
| Significance of impact | What is the ecological importance of the locations impacted by company activities? |
| Reliance on ecosystem services | To what extent does a company depend on ecosystem services, and which ones? |
| Resilience of ecosystem services | What is the ability of ecosystems to reliably provide the services a company relies on? |

# Input Data, Data Availability and Harmonisation

**Overall approach**

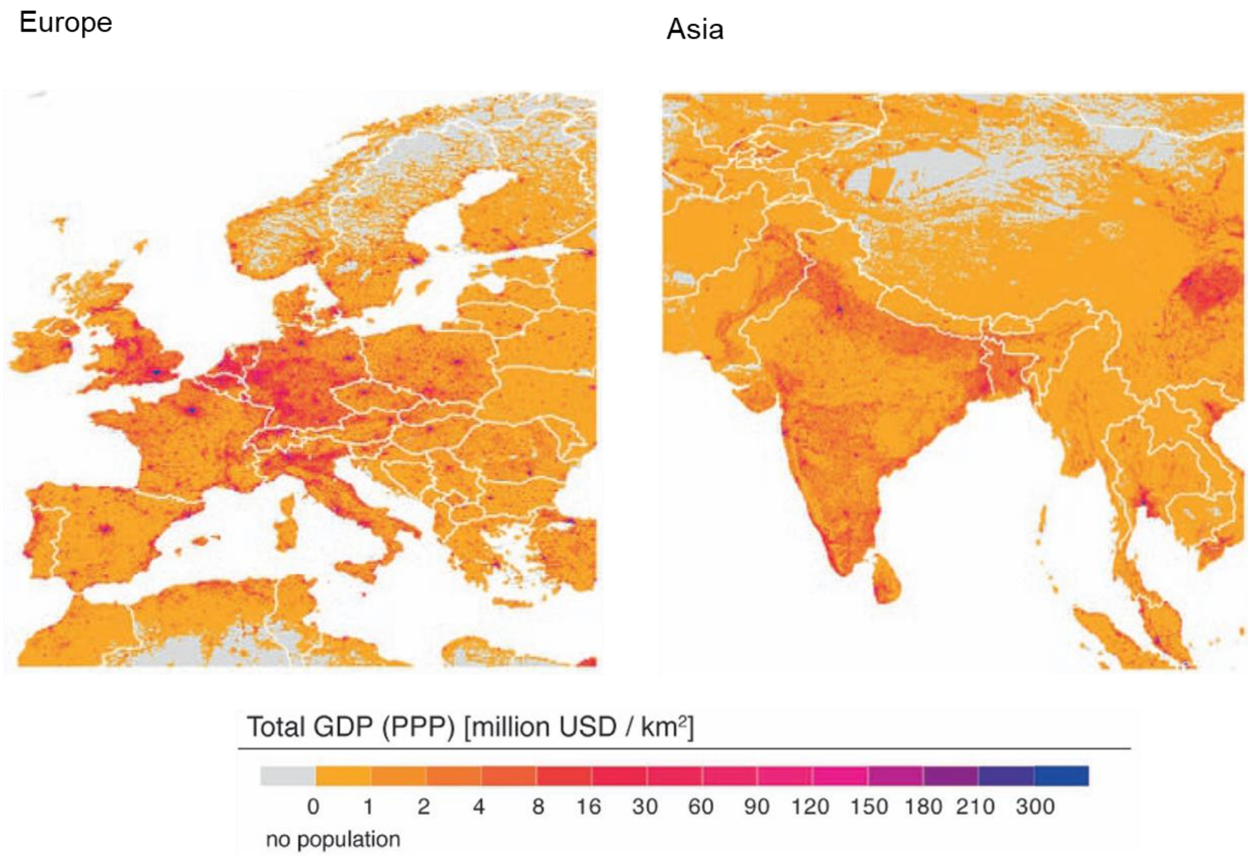
The methodology can use input data with different levels of spatial detail, structured around two core ‘tiers’. The most accurate and spatially precise profiles of nature-related risk exposure will be based on geolocated asset level data (‘Tier 2’ e.g., buffered point, polygon, or line data), in line 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 risks (‘Tier 1’). Methods to estimate likely locations of sector activities within countries are used to refine sectoral approaches used in Tier 1 assessments.

**Tier 1 approach: Country and sector-level data**

Where insufficient asset level data is available to calculate meaningful nature and biodiversity risk metrics, values are estimated based on a country and sector proxies for impact and dependency metrics. Country risk profiles are calculated using GDP weighted average metrics within the country boundaries, based on land use types associated with any given sector, drawing on the relevant state of impact on nature data layer (see further sections below), spatial GDP data sourced from Kummu et al. (2018) and spatial land use data from Winkler, Karina; Fuchs, Richard; Rounsevell, Mark D A; Herold, Martin (2020). Land use data is also complemented with additional layers to identify activities for which the location is not clearly limited to typical land use classes (e.g., urban, agriculture, etc.). This is, for example, the case for mining, oil and gas, as well as infrastructure assets like power generation and road and railways.

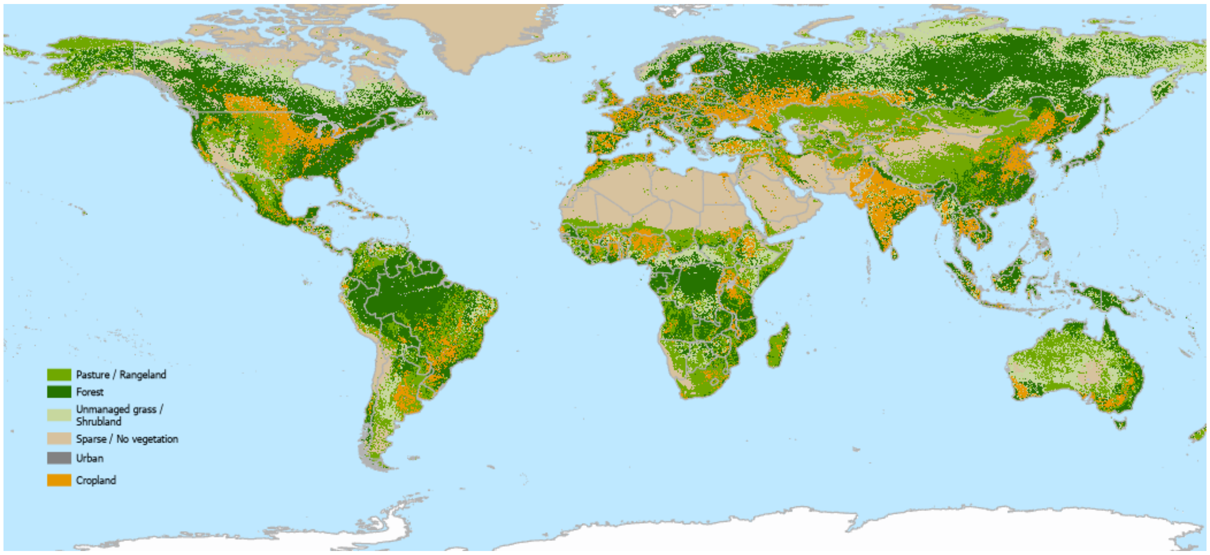
*Figure 3: Maps of GDP layers for Europe and Asia*




Source: Europe and Asia GDP, 5-arc minute resolution, from Kummu et al. (2018)[6]

[6] Kummu, M., Taka, M., Guillaume, J.H.A. 2018. Gridded global datasets for Gross Domestic Product and Human Development Index over 1990–2015. Scientific Data volume 5, Article number: 180004 (2018).

*Figure 4: Global land use map*




Source: Data for 2019, from Winkler, Karina; Fuchs, Richard; Rounsevell, Mark D A; Herold, Martin (2020)

Companies' activities are broken down by business activity and country based on the Trucost Environmental and GeoSeg datasets. Combined with the Trucost Environmental model to estimate land use values in hectares, it is then possible to build a sector and country-specific company profile of land use and revenue generation by business activity.

### **Tier 2** approach: Asset-level **data**

Table 3 describes the asset level data sources and datapoints utilized in S&P Global Sustainable1's Nature & Biodiversity Risk dataset. This includes a range of established S&P Global datasets focusing on energy, real estate, mining, telecommunications, technology, industrials and manufacturing, supplemented with external datasets including cement and steel production asset databases from the Spatial Finance Initiative (McCarten et al. 2021a8; McCarten et al. 2021b9), government regulatory datasets (DEFRA, 202210; European Environment Agency 202011; Government of Canada, 202212; Australian Department for Climate Change, Energy, The Environment and Water 202213) and other sources.

Each asset is mapped to a unique owner identifier (KeyInstn and CIQ ID) enabling linking to other datasets within the S&P Global Capital IQ database, and to the ultimate parent owner name and identifier, which allows for the aggregation of metrics at the owner and parent level. Attribute information for each asset, such as asset type, sector, country, and other details including capacity, production and land use are also captured to inform the analysis.

Of primary importance, the area of land used by each asset is estimated using a hierarchy of input data, as outlined in Table 2.

*Table 2: Asset data input hierarchy*

| Footprint Proxy Code | Footprint Proxy Category | Note |
|---|---|---|
| 100 | Reported Data | Directly reported by the company at the asset level |
| 200 | Other Primary Data | Satellite images or other observed data |
| 300 | Modelled based on Capacity | Any capacity/production value-based model including basic research-based models |
| 400 | Modelled based on Revenue | Any revenue-based model |
| 500 | Sector Averages | Any form of sector or group average, mean, median, aggregation etc |
| 0 | Not Modelled | No polygon, for example if asset is 'planned' but does not yet exist, or asset is underground etc |

*Table 3: S&P Global Sustainable1's Nature & Biodiversity Risk dataset: Asset-level data coverage and sources*

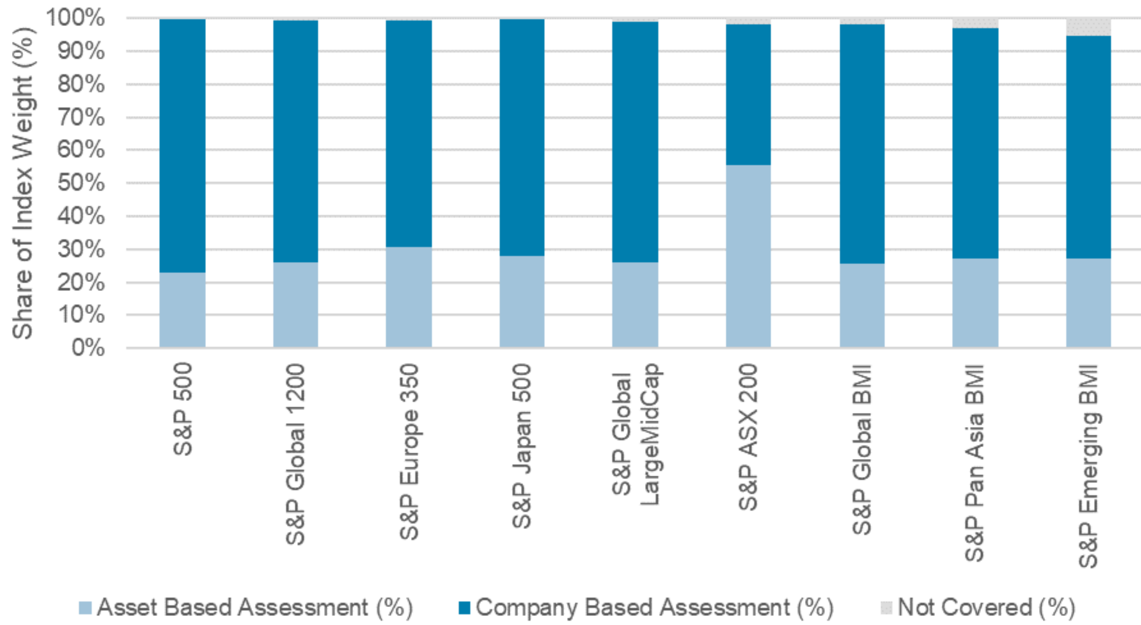
| Sector | Data Source | Asset Count | |
|---|---|---|---|
| | | Core Plus Universe | Expanded Universe |
| Energy | S&P Commodity Insights | 196 | 1,082 |
| | S&P Market Intelligence Gas Receipt/Delivery Points | 18,367 | 28,804 |
| | S&P Market Intelligence LNG Assets | 34 | 81 |
| | IHS Exploration and Production | 10,859 | 21,661 |
| | S&P Market Intelligence Pipelines | 392 | 583 |
| | S&P Market Intelligence Gas Storage | 324 | 412 |
| Industrials & Agriculture | IHS Port | 1,193 | 3,381 |
| | IHS Industrial, Agriculture and Mining | 1,455 | 3,195 |
| | Australian NPRI | 2,036 | 4,890 |
| | Canadian NPRI | 382 | 630 |
| | EU NPRI | 17,766 | 68,589 |
| | IHS Refining and Chemicals | 1,639 | 3,794 |
| | SFI Global Cement | 916 | 1,638 |
| | UK NPRI | 1,126 | 4,502 |

| | | | |
|---|---|---|---|
| | IHS Automobile Manufacturing | 620 | 918 |
| | SFI Global Steel | 563 | 1,101 |
| Metals & Mining | S&P Market Intelligence Coal Mines | 1,086 | 5,058 |
| | S&P Market Intelligence Metals and Mining Properties | 6,001 | 31,692 |
| Power & Utilities | IHS Power and Clean Energy | 15,498 | 35,573 |
| | S&P Market Intelligence Transmission Lines | 5,362 | 7,610 |
| | S&P Market Intelligence Power Plants | 26,305 | 71,847 |
| | S&P Global World Electric Power Plants | 819 | 3,006 |
| Tech & Telecom | S&P Market Intelligence Broadcast Stations | 2,300 | 7,952 |
| | S&P Market Intelligence Kagan Telecommunications Assets | 179,618 | 184,551 |
| | S&P Market Intelligence Data Center Knowledge Base | 3,648 | 7,684 |
| Urban Environment | S&P Market Intelligence Company Headquarters | 49,395 | 183,332 |
| | S&P Market Intelligence Bank Branches | 478,167 | 654,162 |
| | S&P MI Real Estate | 89,166 | 97,867 |
| | S&P Global Sustainable1 | 84,356 | 117,798 |
| | S&P Market Intelligence Office Locations | 42,264 | 135,743 |
| Total | | 1,041,853 | 1,689,136 |

Assets are mapped to corporate owners (or lessees) and ultimate parent identifiers in the S&P Capital IQ database using string matching techniques to enable efficient linking to financial and other market datasets in the S&P Global databases. The S&P Global asset database will be continually expanded to integrate new asset level datasets sourced within S&P Global and/or externally.

Figure 5 presents coverage of selected S&P Global Dow Jones Indices with asset based and revenue exposure-based metrics as of 30th September 2023. As shown, asset level data is available for companies representing 98% of index weight in the S&P 500, S&P Europe 350, ASX 200 and S&P Global LargeMidCap Index. Coverage of asset level data is expected to increase as additional asset datasets are incorporated.

*Figure 5: S&P Global's Nature and Biodiversity Risk Dataset Coverage Summary*




Source: S&P Global Sustainable1, index composition as of 30th September 2023

# Assessing Nature Dependencies

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. 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. For example, mining businesses are heavily dependent on the supply of water. As such, a mining business would be at greater risk if one of its mines may 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 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.

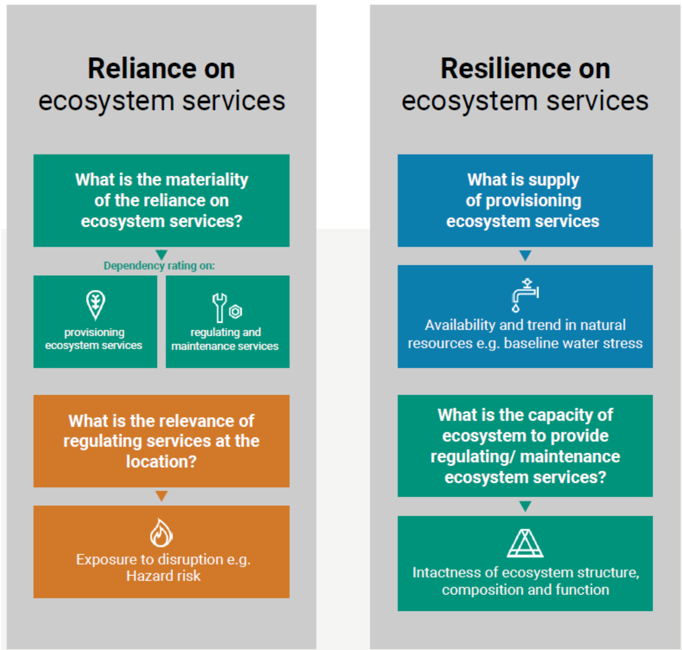
**Definition of dependency risk**

In accordance with the definition of risk in the TNFD framework (v0.2), the risks associated with business dependencies on nature are driven by:

- The level of reliance on (or exposure to) ecosystem services: which ecosystem services the business depends upon and to what extent, and
- The risk that ecosystems within which a business operates stop providing a continued flow of those services (or likelihood of ecosystem failure).

These two concepts represent the core 'pillars' of the dependency-based risk profiling methodology, as shown on Figure 6.

*Figure 6: Pillars of Dependency Risk Assessment in S&P Global Sustainable 1 Nature & Biodiversity Risk Assessment*




Source: UNEP-WCMC – S&P Global: Nature Risk Profile: A methodology for profiling nature related dependencies and impacts. https://www.spglobal.com/esg/solutions/nature-risk-profile-methodology.pdf

### Reliance risk score: definition and calculation

1. Materiality score

1.1 Definition

The concept of materiality describes the degree to which a business activity or production process depends on the benefits provided by ecosystem services. In this methodology, ecosystem services follow the ENCORE knowledge base classification (Natural Capital Finance Alliance 2022)[7], which was built according to the Common International Classification of Ecosystem Services (CICES) comprising a five-level hierarchical structure, for example: Section (e.g., Provisioning), Division (e.g., Nutrition), Group (e.g., Terrestrial plants and animals for food), Class (e.g., crops), and Class type (e.g., wheat). Cultural ecosystem services are not included in this methodology as they are not

[7] 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.

considered to be direct inputs or to enable production processes. The CICES framework has been simplified as follows for the purposes of this methodology:

A complete list of ecosystem services and their definitions is available in Appendix 3.

## 1.2 General case

In the general case application, the materiality score component of the dependency scores is taken from the ENCORE knowledge base, which 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 ENCORE database currently covers 87 processes representing 139 GICS subindustries. The materiality of each of the 21 ecosystem services for production processes is scored using categorical scores, ranging from Very Low to Very High, and according to the following criteria:

*Table 4: Materiality ratings logic and their corresponding numerical scores*

| Qualitative Rating | Justification | Numerical Score |
|---|---|---|
| No dependency | The production process does not depend on the ecosystem service | 0 |
| Very Low | Very small or limited loss of functionality and very small or limited<br>financial loss. The production process can continue without change and there is very limited or no<br>financial loss | 0.2 |
| Low | Very small or limited loss of functionality and/or very small or limited financial<br>loss. The production process can continue without changing and/or there is very limited or no<br>financial loss. | 0.4 |
| Moderate | The loss of functionality is moderate, or the financial impact is moderate.<br>Production is disrupted or financial loss is non-negligible. | 0.6 |
| High | The loss of functionality is severe and/or the financial impact is moderate, or vice-versa. Production is disrupted and/or financial loss is non-negligible. | 0.8 |
| Very High | The loss of functionality is severe, and the expected financial impact is severe. | 1 |

Source: 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.

*Table 5: Example for Integrated Oil and Gas*

| Ecosystem Service | Score |
|---|---|
| Filtration | 0.6 |
| Mass stabilisation and erosion control | 0.6 |
| Climate regulation | 0.6 |
| Surface water | 0.8 |
| Bioremediation | 0.6 |
| Flood and storm protection | 0.8 |
| Water quality | 0.8 |
| Ground water | 1 |

Source: 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.

### 1.3 Surface water and ground water

Where possible, the materiality assessment can incorporate company-specific data instead of the ENCORE activity-based score. This is the case for surface and ground water provision.

The scores use the extensive Trucost Environmental dataset, which contains disclosed and modelled water withdrawal quantities for companies in S&P Global Sustainable1's Nature & Biodiversity Risk dataset. These water withdrawal volumes are used to derive water intensities per million USD revenue, which are then normalised to express them as a score from 0 to 1. By doing so, any company's (or asset's) water intensity can be scored according to this normalised scale.

### 1.4 Practical application

Tier 1 application:

Each process in the ENCORE database is mapped to one or several sectors in the 464 Trucost sector classification system to calculate a sector-level materiality score for each ecosystem service. The sectoral breakdown of companies' revenue is then used to calculate a revenue-weighted average materiality score.

Tier 2 application:

Each process in the ENCORE database is mapped to one or more of each of the asset types covered in S&P Global's asset database to calculate an asset-level materiality score for each ecosystem service. The modelled value of each asset in the company's portfolio is then used to calculate a value-weighted average materiality score.

Additional considerations:

For sectors or asset types underpinned by more than one production process, materiality scores for each production process are aggregated at the ecosystem service level as follows:

- Where it is deemed that disruption to any of the production processes would hinder the production of the overall sector because they are complementary to each other (e.g., processes run in a linear manner): the maximum scores for the production processes are taken to represent the overall sector.

- Where the production processes are mutually exclusive and can be a substitute to each other (e.g., processes can run in parallel): the average of the scores is taken.

## 2. Relevance score

### 2.1 Definition

The potential for benefits to be gained from several 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 score estimated at the sector or business activity level.

Consequently, for certain ecosystem services, materiality scores should be adjusted, or tilted, for the potential location-specific benefit, which may be higher or lower than the average of the activity. A list of services that are likely to need adjustment for local relevance is provided in Appendix 4.

### 2.2 Practical application

Tier 1 application:

Due to the challenges of estimating a meaningful relevance score at the regional level, the relevance score is not calculated under the Tier 1 approach and all materiality scores make up the reliance score.

Tier 2 application:

For the ecosystem services where a relevance adjustment is required, the relative benefit of each service is assessed based on the applicable geospatial layer by estimating the relative exposure at a given asset-location. Layers are normalised into a score from 0 to 1, and the normalised value from each layer at any given asset location is used as the relevance score for that asset.

The list of geospatial indicators used to assess each relevance score is provided in Appendix 5.

## 3. Reliance score

### 3.1 Definition

A given business or asset's reliance score on each of the 21 ecosystem services is calculated as the geometric mean of the materiality and the relevance scores (where applicable):

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

Where:

- i: Ecosystem service i

- n: Number of relevant score components for ecosystem service i (2, or 1 if relevance score is not applicable)

- materiality and relevance scores range from 0 to 1

Reliance scores therefore range from 0 (no reliance) to 1 (very high reliance). When a relevance score is not applicable for a given ecosystem service, the reliance score is equal to the materiality score.

### 3.2 Practical application

The calculation of the reliance score is identical for both Tier 1 and Tier 2 approaches and consists in applying the formula in the above section.

**Resilience risk score: definition and calculation**

1. Definition

The likelihood that dependency-related risks materialize depends on the capacity of ecosystems to continue to provide the necessary ecosystem services. Declines in the state of nature often reduce the resilience of ecosystems and therefore their capacity for providing ecosystem services. 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. The resilience score, therefore, quantifies the risk of resilience of a specific ecosystem service in a given location.

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 as it depends on the health, or integrity, of the entire ecosystem. It remains important that initial scores for reliance are combined with the resilience risk of the ecosystems providing the ecosystem services.

A list of services for which a location-specific resilience risk can be calculated is provided in Appendix 4.

2. Practical application

Despite the uncertainty associated with measuring ecosystem capacity, it is reasonable to assume that an ecosystem in good condition is likely to provide these services. Therefore, an initial proxy for the resilience (or lack of) of these services is the integrity (or lack of) of the ecosystems providing the services. Where available, additional geospatial data layers are used to complement this assessment with data specific to the service considered.

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 it is therefore recommended to assess the condition of the ecosystem (stock of natural capital) rather than the actual flows of services it currently provides (flow of ecosystem 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 over a relevant area of the ecosystem operated in can act as a proxy for its capacity to provide services:

- For 'local' services (e.g., Buffering and attenuation of mass flows) the relevant proxy value directly at the location of asset (over the area used by the asset) is used;

- For 'landscape' services (e.g., Pollination), the average relevant proxy value over a 10km buffer as an estimated proxy is used;

- For any services centring around hydrology or erosion control (e.g., Ground and surface water or mass stabilisation and erosion control), the average relevant proxy over the basin area (HydroSHEDS level 7[8]) is used.

The list of geospatial indicators used to assess each ecosystem service resilience score is provided in Appendix 5.

Tier 1 application

Each ecosystem resilience risk is assessed (when relevant) by using the applicable proxy (Ecosystem Integrity Index or other) average value over the relevant area of each country where a sector likely operates, which is defined by the sector considered (see previous sections). While it would be recommended to use the maximum value to characterise the maximum level of risk of any operation, given the large areas over which such resilience risk is estimated, it is more appropriate to use the average to build regional risk proxies.

Tier 2 application

For the relevant ecosystem services, the resilience risk is estimated based on the applicable proxy's geospatial layer maximum value over the asset area. Layers are normalised into a score from 0 to 1, and the normalised value from each layer at any given asset location is used as the resilience score for that asset. The maximum value characterises the riskiest area of any given asset, and therefore is considered a conservative approach to characterises the risk of the asset itself. This is particularly relevant for linear assets such as pipelines and transmission lines.

[8] https://www.hydrosheds.org/about

**Composite dependency risk score: definition and calculation**

1. Definition

A given business or asset's dependency score on each of the 21 ecosystem services is calculated as the geometric mean of the reliance (risk exposure) and the resilience (risk likelihood) scores, where applicable, for any given location:

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

Where:

- i: Ecosystem service i

- n: Number of relevant score components for ecosystem service i (2, or 1 if resilience score is not applicable)

- reliance and resilience scores range from 0 to 1

Composite dependency scores therefore range from 0 (no dependency risk) to 1 (very high dependency risk). When a resilience score is not applicable for a given ecosystem service, the dependency score is equal to the reliance score.

2. Practical application

Tier 1 application

Each ecosystem dependency score is assessed (when relevant) by combining the applicable reliance and resilience score over the relevant area of each country where a sector likely operates, which is defined by the sector considered (see previous sections). In some cases where relevance and resilience apply, a composite layer is used, and the average value is taken from this layer.

Tier 2 application

Each ecosystem dependency score is assessed (when relevant) by combining the applicable reliance and resilience over the asset area. In some cases where relevance and resilience apply, a composite layer of the applicable proxies is used, and the maximum value is taken from this layer.

**Aggregated dependency risk scores: definition and calculation**

1. Definition

To characterise the overall dependency risk at the asset or sector level, it is useful to produce an aggregated score which combines all 21 ecosystem services scores.

2. Calculation

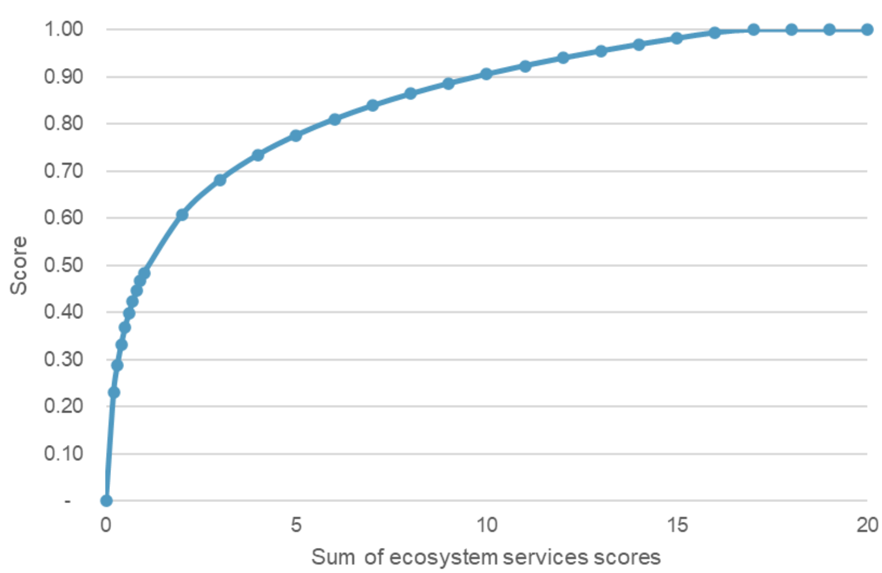
Business risks are not linear, as they generally stem from a few high dependencies to a few ecosystem services. At the same time, each additional risk only marginally increases the overall risk (decreasing marginal contribution). It is therefore not appropriate to use a linear aggregating function (e.g., simple sum or arithmetic average). Instead, a logarithmic function is used, which takes as input the sum of all 21 ecosystem services dependency scores and was fitted accordingly:

$$Aggregate\ Dependency\ Score_j^a = Min\left[\frac{log\left(12 * \sum_{i=1}^{21} SigScore_i\right) + 1}{2.3}, 1\right]$$

Where:

- $SigScore_i$ = Sigmoid transform of Ecosystem Service score i
- a = asset or sector a
- i = number of ecosystem services
- j = materiality, relevance, reliance, resilience, or composite score

*Figure 7: Dependency scores aggregating function*



As simple sum of ecosystem scores, however, does not differentiate well between different dependency profiles. For example, if Company A has two high dependency scores of 0.8 and Company B has eight low dependency scores of 0.2, the sum of their dependency scores is both equal to 1.6, but their profiles are very different. Company A is likely carrying higher dependency risks than Company B.

To account for this, each individual ecosystem dependency score is transformed using a sigmoid function, which in effect reduces the overall impact or low scores and conversely increases the impact of high scores to the aggregated dependency score. The sigmoid function profile was fitted accordingly as follows:

$$SigScore_i = {}^{1}/_{[1 + exp(-(Score_i \ - 0.5) \ * 15)]}$$

Where:

- $SigScore_i$ = Sigmoid transform of Ecosystem Service score i
- i = number of ecosystem services

*Figure 8: Profile of sigmoid transformation of ecosystem dependency scores, compared to a linear application*

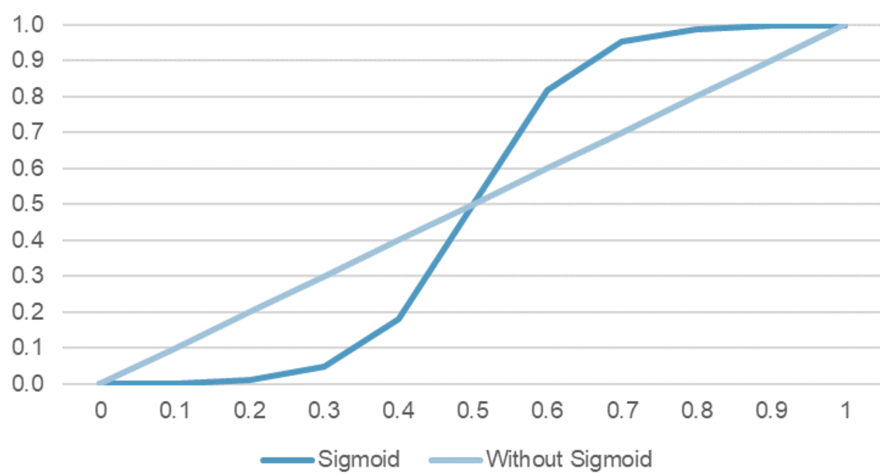
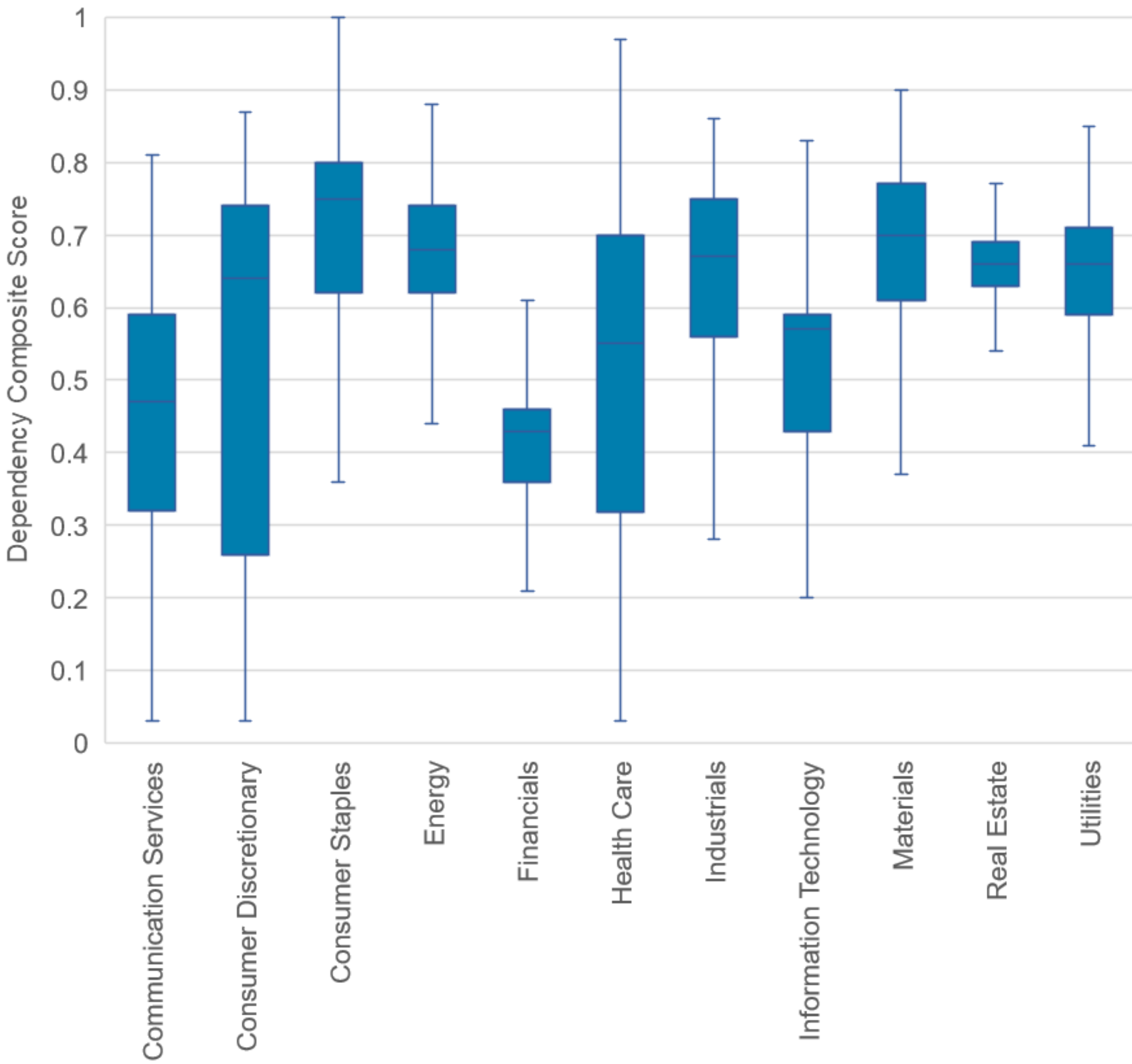


Figure 9: Aggregated dependency risk scores:  Interquartile distribution by GICS Sector (Core Plus Universe)




Source: S&P Global Sustainable1, October 2023.

# Assessing Nature Impacts

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.

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.

**Definition of impact risk**

The levels of risk associated with a business' impacts on nature will be closely related to:

- The magnitude of impacts, defined as the Ecosystem Integrity Footprint: the degree to which business operations apply pressures and cause a footprint on the state of nature based upon both:
    - The area occupied (land use), and
    - The ecosystem integrity degradation (Ecosystem Integrity Impact Index), and
- The significance of the locations impacted, defined as the significance index: significance could be:
    - Societal (anthropo-centric), or
    - Environmental (biodiversity centric)

To provide a decision-useful metric that enables comparison between business operations, land area, ecosystem integrity degradation and ecosystem significance are brought together to calculate the equivalent impact on the most significant areas globally in terms of biodiversity conservation and ecosystem services provision. This produces an Ecosystem Footprint expressed as the equivalent number of hectares in the most globally significant ecosystems that would be fully degraded by the company's operations.

**Magnitude: definition and calculation**

1. Definition

In this first implementation of the methodology, the magnitude of impact is defined by the area of land impacted, and the expected intensity of pressures to the impacted ecosystem associated with specific land use types. The core approach to quantifying magnitude of impact is to calculate a footprint on ecosystem integrity, expressed as a condition-adjusted area, in hectares equivalent of a pristine ecosystem.

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.

Through adjustments for the specific pressures exerted and mitigation measures applied by individual businesses, it will be possible in future iterations to characterize pressures of a business based on actual management in a given location.

2. Calculation

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. In this first implementation of the Nature Risk Profile[9] methodology, magnitude is defined according to the 'characteristic' approach, meaning that any business impact is estimated by comparing the current state of nature in a given location with an 'intact' reference state (condition = 1).

This provides a measure of the equivalent area where condition is reduced to zero, the Ecosystem Integrity Footprint is calculated using the below formula:

$$Ecosystem\ integrity\ footprint\ (Condition\ adjusted\ area\ in\ ha\ equivalent)$$

$$= Land\ Use\ (ha) * \ Ecosystem\ Integrity\ Impact\ Index$$

$$= Land\ Use\ (ha)\ *\ [\ 1 - Characteristic\ Ecosystem\ Integrity\ Index\ ]$$

Where:

- Area: area occupied by an asset or business activity, in hectares

[9] UNEP WCMC – S&P Global: Nature Risk Profile: A methodology for profiling nature related

dependencies and impacts. Available here: https://www.spglobal.com/esg/solutions/nature-risk-profile-methodology.pdf

- Characteristic Ecosystem Integrity Index: average EII value over the area occupied by an asset or business activity
- Ecosystem integrity impact index = 1 – Characteristic Ecosystem Integrity Index

While there are multiple different metrics that describe condition based on models, the Ecosystem Integrity Index is used as a best practice metric for calculating the 'remaining condition' element of the footprint calculation.

Taking the average Ecosystem Integrity Index values over a specific location 'characterizes' the average integrity of ecosystems within that area. It captures the impact of all pressures at that location. This provides an estimate of the overall resulting or current state of ecosystem integrity at the location that can be used to track progress.

Tier 1 application

When asset-level information is not available, the Ecosystem Integrity Footprint is assessed by:

- Calculating the Ecosystem Integrity Impact Index average value over the relevant area of each country where a sector likely operates, which is defined by the sector considered and land use class (see previous sections), and
- Multiplying the absolute land area used by a company with the ecosystem integrity impact index.

This is done for each of the composition, structure, and function components of the Ecosystem Integrity Index, as well as the Ecosystem Integrity Index itself.

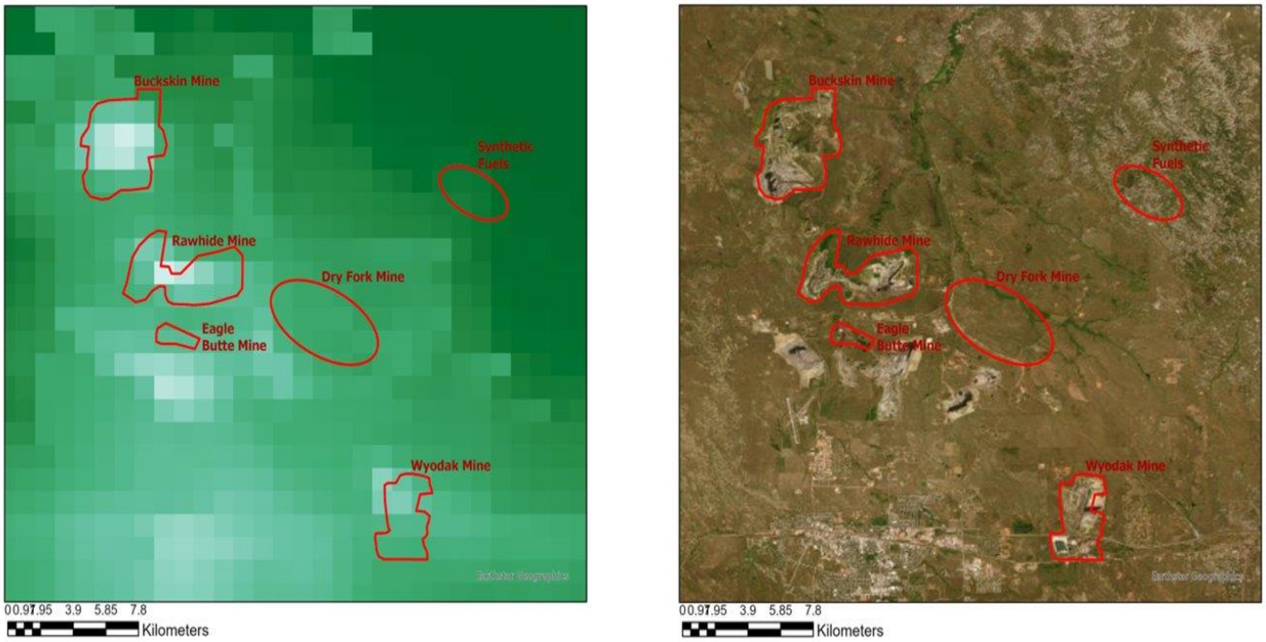
Tier 2 application

When asset-level information is available, the Ecosystem Integrity Footprint is assessed by:

- Calculating the Ecosystem Integrity Impact Index average value over the area occupied by a given asset, and
- Multiplying the absolute land area occupied by the asset with the Ecosystem Integrity Impact Index.

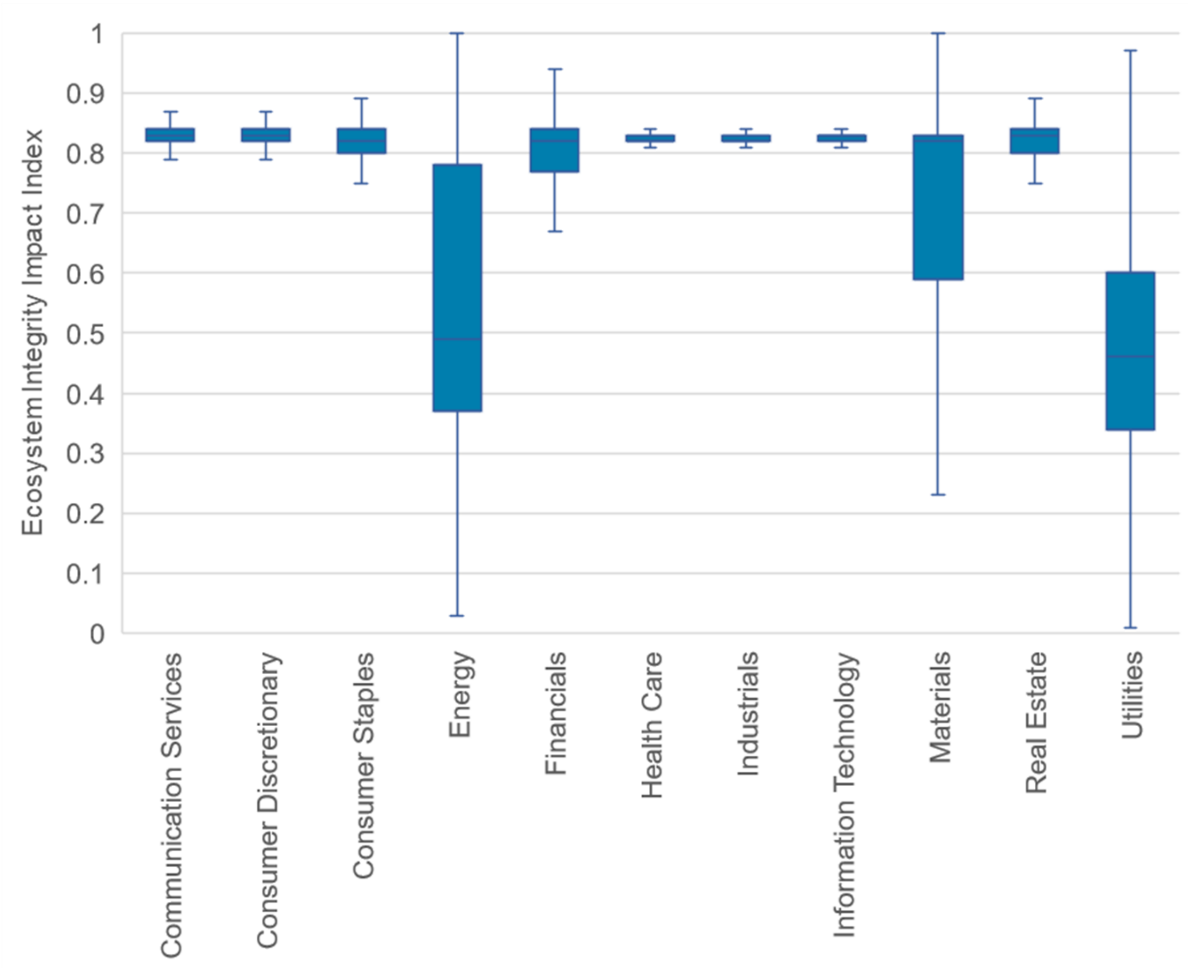
This is done for each of the composition, structure, and function components of the Ecosystem Integrity Index, as well as the Ecosystem Integrity Index itself.

*Figure 10: Modelled EII layer (left) and Satellite image (right) of sample coal mines*




Source S&P Global Sustainable1, Maus et al. (2022) Polygons either from Maus et al. (2022) or buffered points based on Ore Processed and Maus polygon areas

*Figure 11: Ecosystem Integrity Impact Index: Interquartile distribution by GICS Sector (Core Plus Universe)*




Source: S&P Global Sustainable1, October 2023.

**Significance: definition and calculation**

A limitation of only looking at the magnitude of impact is that the relative significance of the ecosystems impacted is not fully considered. 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 society at large.

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.

In this methodology, significance is assessed through two complementary dimensions:

- Significance for biodiversity conservation: Species Significance Index
- Significance for the contribution of benefits to people: Ecosystem Contribution Index

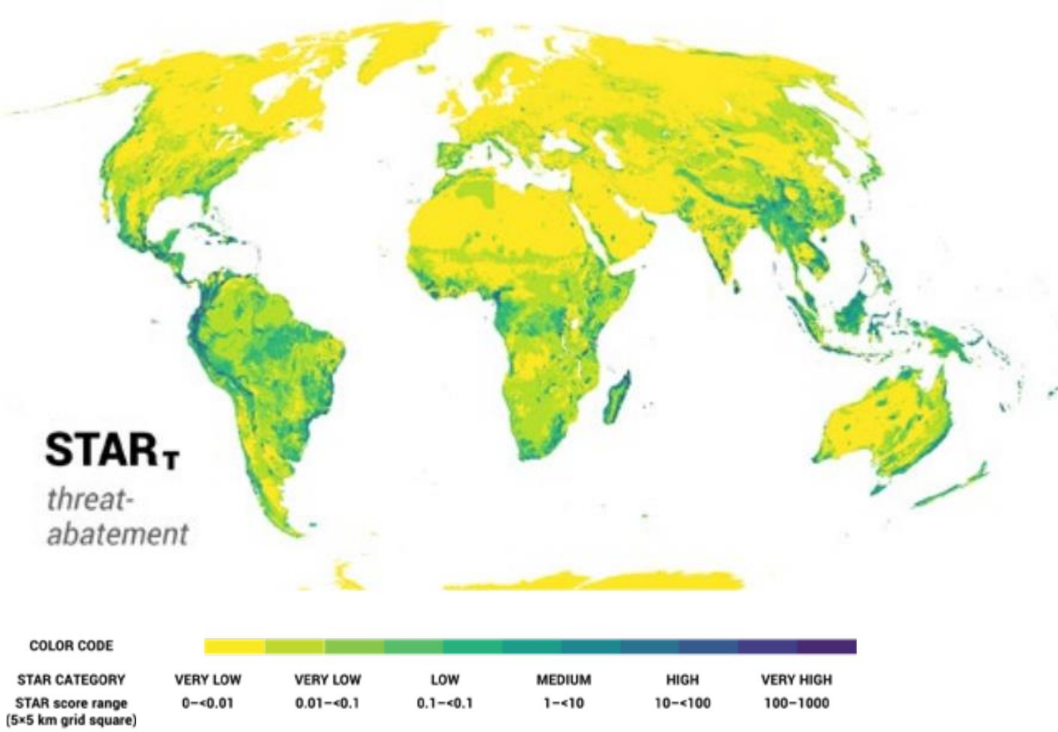
1. Species Significance Index

1.1 Definition

The Species Significance Index quantifies the relative importance of each location for biodiversity conservation. It provides a species-centric characterisation of significance. Here the $STAR_T$ metric is used, which 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 calculated across the range of the species and aggregated into a final number. High $STAR_T$ 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.

*Figure 12: The STAR Threat Abatement metric*



Source: Integrated Biodiversity Assessment Tool (IBAT) provided by BirdLife International, Conservation International, International Union for Conservation of Nature and United Nations Environment Programme World Conservation Monitoring Centre. Please contact ibat@ibat-alliance.org for further information.

### 1.2 Calculation

Absolute $STAR_T$ values may be difficult to interpret and integrate into a composite footprint metric, therefore the global layer is normalised from 0 (no significance) to 1 (very high significance) into an index that represents the significance of a location, relative to a threshold of very high significance.

The $STAR_T$ metrics has an extremely skewed distribution (see figure 12 above), with very high scores found in a limited number of critical locations, and low scores in most locations on the planet. This represents the current state of biodiversity richness and threats globally.

#### Tier 1 application

When asset-level information is not available, the Species Significance Index for any sector and country is calculated as the average value of the index over the relevant area of each country where a sector likely operates, which is defined by the sector considered and land use class (see previous sections).

#### Tier 2 application

When asset-level information is available, the Species Significance Index for any asset is calculated as the average value of the index over the area occupied by a given asset.

## 2. Ecosystem Contribution Index

### a. Definition

The Ecosystem Contribution Index quantifies the relative importance of each location for the provision of services to people and society. It provides an anthropo-centric characterisation of nature's contributions to human wellbeing. Here the concept of Critical Natural Assets is used, as defined by Chaplin-Kramer et al. (2022)[10], which represent areas that are integral to securing 90% of current levels of ecosystem service provision. Beyond this target there are diminishing returns, with disproportionately more natural area required to reach incrementally higher magnitudes of provision of Nature Contributions to People (NCP).

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[10] Chaplin-Kramer, R., Neugarten, R.A., Sharp, R.P. et al. Mapping the planet's critical natural assets. Nat Ecol Evol 7, 51–61 (2023). https://doi.org/10.1038/s41559-022-01934-5

Critical Natural Assets are defined separately for global ecosystem service provision (e.g., carbon sequestration) and local ecosystem service provision (e.g., pollination). Losing these critical assets would lead to disproportionately large losses in nature's contribution to people.

List of local NCP modelled:

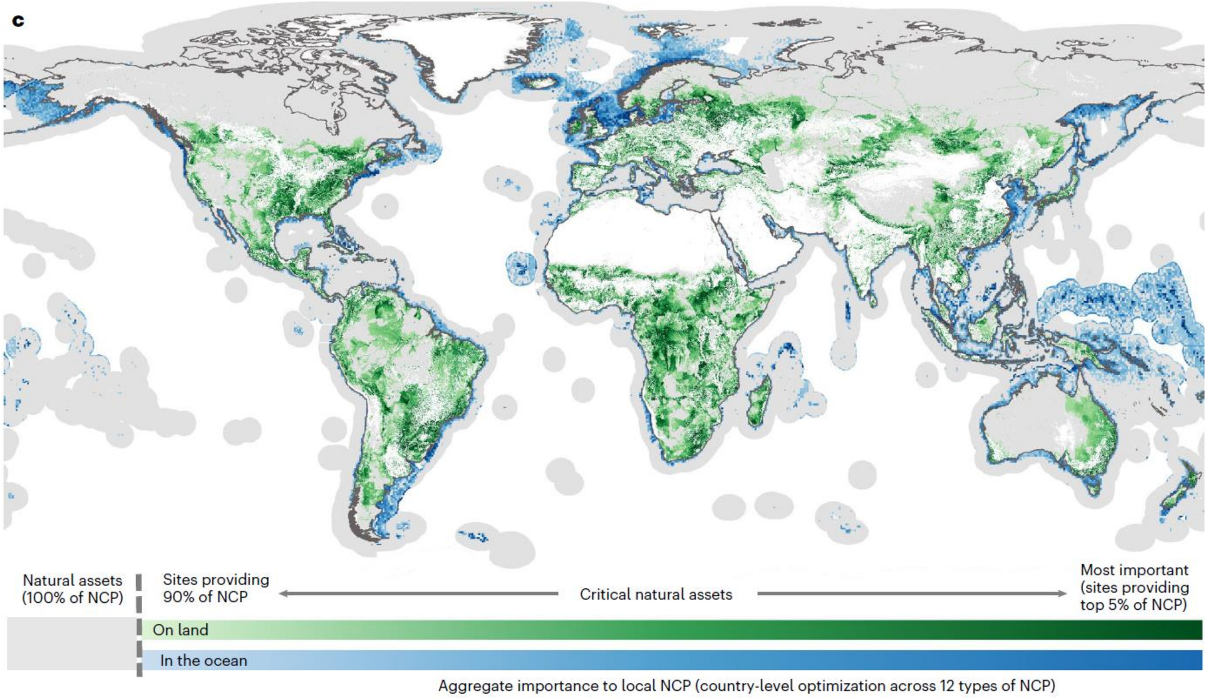
- Nitrogen retention for water quality regulation
- Sediment retention for water quality regulation
- Pollinator habitat sufficiency for pollination-dependent crops
- Fodder for livestock
- Timber production
- Fuelwood production
- Flood regulation
- Riverine fish harvest
- Access to terrestrial nature (for local recreation and gathering)
- Coastal risk reduction (terrestrial and marine)
- Marine fish harvest
- Marine recreation (coral-reef tourism and associated livelihoods)

List of global NCP modelled:

- Vulnerable terrestrial ecosystem carbon storage
- Atmospheric moisture recycling

The highest 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.

*Figure 13: Map of critical natural assets for local Nature Contributions to People (NCP)*




Darker shades connoting critical natural assets that are associated with higher levels of aggregated NCP. Grey areas show the extent of remaining natural assets not designated 'critical' but included in this analysis; white areas (cropland, urban and bare areas, ice and snow, and ocean areas outside the EEZ) were excluded from the optimization.

Source: Chaplin-Kramer, R., Neugarten, R.A., Sharp, R.P. et al. Mapping the planet's critical natural assets. Nat Ecol Evol 7, 51–61 (2023). https://doi.org/10.1038/s41559-022-01934-5

b. Calculation

Each score of the original layer is normalised into an index which values range from 0 (no significance) to 1 (very high significance). Because the initial layer scores already represent deciles, there is no need to normalise with a threshold value.

Tier 1 application

When asset-level information is not available, the Ecosystem Contribution Index for any sector and country is calculated as the average value of the index over the relevant area of each country where a sector likely operates, which is defined by the sector considered and land use class (see previous sections),

Tier 2 application

When asset-level information is available, the Ecosystem Contribution Index for any asset is calculated as the average value of the index over the area occupied by a given asset.

3. Ecosystem Significance Index (composite)

   a. Definition

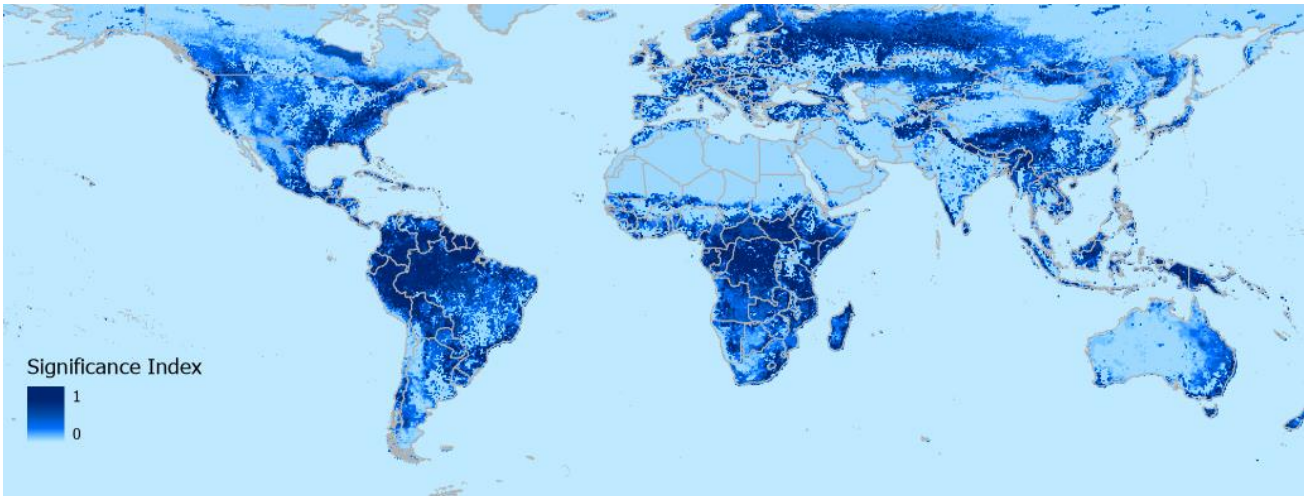
The objective of the composite Ecosystem Significance Index is to capture different dimensions of significance, and therefore combines the Species Significance index and the Ecosystem Significance Index into a composite index.

It may be possible in future iterations of the methodology to incorporate additional dimensions, if relevant.

   b. Calculation

For any given location (or pixel), the composite Significance Index is calculated as the maximum of the Species Significance index layer and the Ecosystem Significance Index layer, and its values also range between 0 (no significance) to 1 (very high significance). This generates a new composite layer incorporating both components' information.

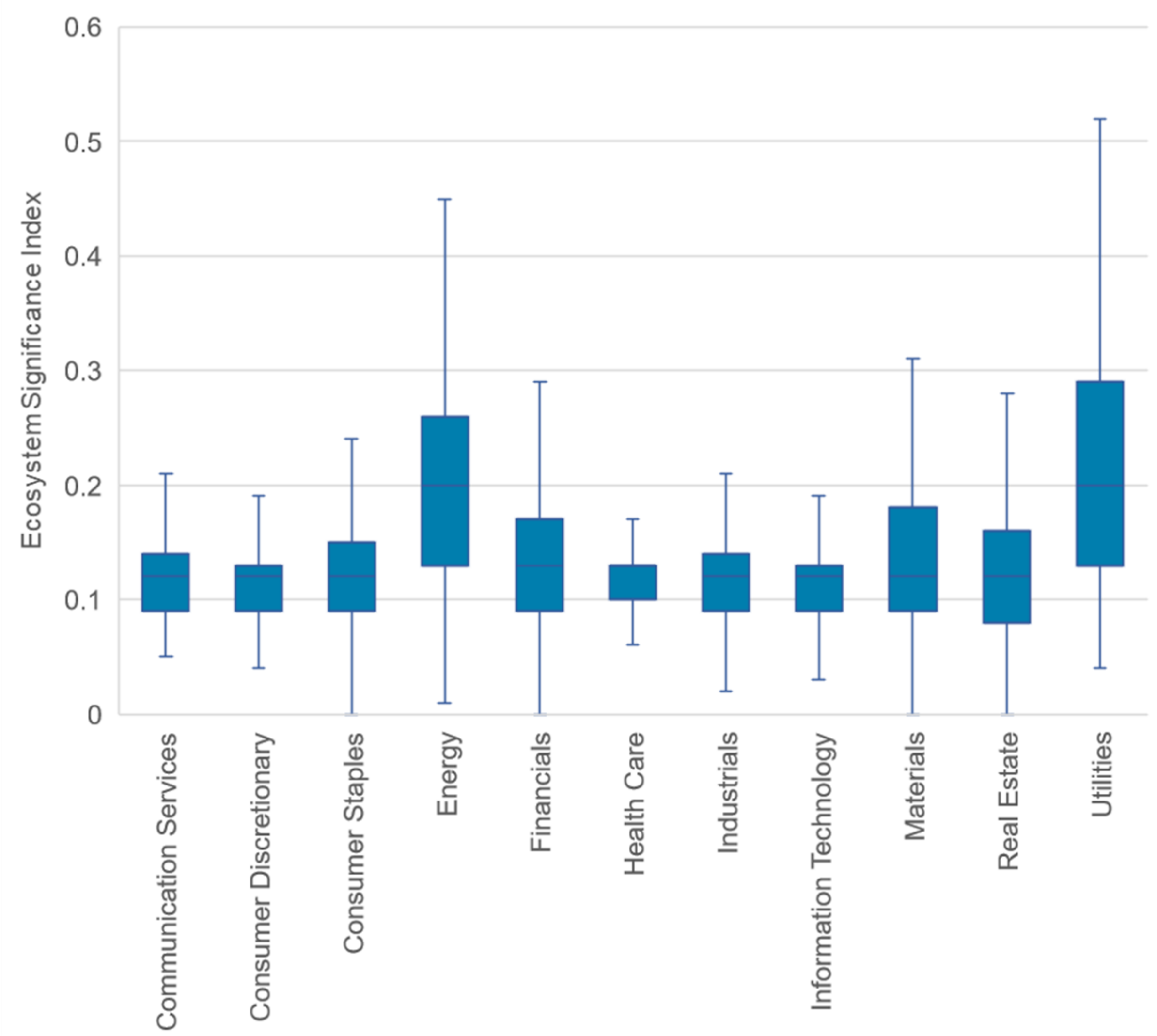
*Figure 14: Ecosystem Significance Index layer*




Darker shades indicate areas of high significance.

Source: S&P Global Sustainable1

*Figure 15: Ecosystem Significance Index: Interquartile distribution by GICS Sector (Core Plus Universe)*




Source: S&P Global Sustainable1, October 2023.

Tier 1 application

When asset-level information is not available, the Significance Index for any sector and country is calculated as the average value of the composite index layer over the relevant area of each country where a sector likely operates, which is defined by the sector considered and land use class (see previous sections),

Tier 2 application

When asset-level information is available, the Significance Index for any asset is calculated as the average value of the composite index layer over the area occupied by a given asset.

**Ecosystem Footprint: definition and calculation**

1. Definition

To account for both the magnitude of impact and the significance of the areas impacted, S&P Global Sustainable1's Nature & Biodiversity Risk dataset introduces a headline metric, the Ecosystem Footprint. Similar to the Ecosystem Integrity Footprint, this metric is a condition-adjusted footprint in hectares equivalent of a pristine ecosystem, but it additionally weights each location impacted by its relative significance, using the Significance Index described above.

This metrics allows to express any impact in a single metric that is not only condition-adjusted, but also significance weighted. The result is a footprint expressed in hectares equivalent of the most pristine and significant areas globally. It is equivalent to expressing any business impact in hectares equivalent of the most pristine and biodiverse areas of the Amazon or Borneo rainforests, for example.

While this quantity does not correspond to an actual physical area to be managed (or directly impacted), it allows to express any impact, across any ecosystem globally, into a single metric. This is similar to expressing different greenhouse gasses into a ton of CO2 equivalent so that they can be aggregated and therefore compared across companies, sectors, and geographies, but in the context of nature and ecosystems.

2. Calculation

Any area (polygon or pixel) impacted by an asset or sector is weighted for significance and integrity impact by multiplying each pixel area with the Significance Index and the Ecosystem Integrity Impact Index applicable to that location, as per the formula below:

$$Ecosystem\ Footprint_i = \sum_{j=1}^{n} (Land\ Use\ (ha)_j * Ecosystem\ integrity\ impact\ index_j * Ecosystem\ significance\ index_j)$$

Where:

- i: Sector or asset i

- n: Number of polygons or pixels j impacted by sector or asset i

Tier 1 application

When asset-level information is not available, the Ecosystem Footprint is computed by:

- Calculating the composite significance-weighted Ecosystem Integrity Impact Index average value over the relevant area of each country where a sector likely operates, which is defined by the sector considered and land use class (see previous sections), and

- Multiplying the absolute land area used by a company with the Ecosystem Integrity Impact Index.

Tier 2 application

When asset-level information is available, the Ecosystem Footprint is computed by:

- Calculating the average value of the significance-weighted Ecosystem Integrity Impact Index composite layer over the area occupied by a given asset, and

- Multiplying the absolute land area occupied by the asset with the Ecosystem Integrity Impact Index.

**Additional contextual significance indicators**

In addition to the impact metrics above, S&P Global Sustainable1's Nature & Biodiversity Risk dataset contains additional significance flags. When asset-level information is available, these contextual metrics provide additional binary flags on the significance of the location of the assets. For the avoidance of doubts, these indicators are not estimated under the Tier 1 approach where asset-level information is not available.

1. Overlap with Key Biodiversity Areas (KBAs)

1.1 Definition

Key Biodiversity Areas (KBAs) are sites contributing significantly to the global persistence of biodiversity [11]. 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)[12]. 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).

1.2 Calculation

Each asset in the S&P Global asset database is assessed for a potential overlap with a KBA, based on the area estimated (polygon). When an overlap is found, an estimate of the overlapping area is also provided.

2. Overlap with Protected Areas (PAs)

2.1 Definition

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"[13]. 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.

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[11] 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

[12] 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/policiesstandards/performance-standards/ps6

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

## 2.2 Calculation

Each asset in the S&P Global asset database is assessed for a potential overlap with a PA, based on the area estimated (polygon). When an overlap is found, an estimate of the overlapping area is also provided.

*Figure 16: Selected mining assets and KBAs in Mexico*


As of April 2022.

Mapping layer: UN Geospatial. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Sources: S&P Global Sustainable1; S&P Global Market Intelligence. Key Biodiversity Area data downloaded March 2022 from the Integrated Biodiversity Assessment Tool (IBAT)[14]

[14] Integrated Biodiversity Assessment Tool (IBAT) provided by BirdLife International, Conservation International, International Union for Conservation of Nature and United Nations Environment Programme World Conservation Monitoring Centre. Please contact ibat@ibat-alliance.org for further information.

# Aggregating Impacts and Risks to the Company Level

**Dependency metrics aggregation**

Tier 1 application

Where asset-level information is not available, dependency metrics are estimated based on the revenue and country-weighted average of country-sector dependency proxy scores for each ecosystem service, and then aggregated into an aggregate score as per the formula below:

$$Score_a = \sum_{i=1,\ j=1}^{n,m} \left(W_{i,j} * D_{i,\ j}\right)$$

Where:

- $Score_a$: Dependency score of company a

- n: Number of countries a company operates in

- m: Number of sector j a company operates in

- $W_{i,j}$: Weight of country i and sector j combination in company revenue

- $D_{,j}$: Aggregate dependency score in country i and sector j combination

- l: Number of country-sector combinations in company portfolio

- c: Weight of country c in company revenue

- s: Weight of sector s in company revenue

Companies evaluated using company-level data are categorized as Data Quality: “Company-level analysis”.

Tier 2 application

Asset-level dependency metrics are aggregated at the company level as a weighted average of all mapped assets’ scores, with weights based on assumed asset values for each asset type:

- Assets are mapped to any company which is either the direct owner (including multiple ownership), or the ultimate parent of such direct owner. As such, any asset can be mapped to more than one company.

- Assumed asset values were derived from a literature review and are intended to be indicative of the relative value of each asset type within a company portfolio (see examples in Table 6).

$$Score_a = \sum_{i=1}^{n} (W_i * D_i)$$

Where:

- $Score_a$: Dependency score of company a

- n: Number of assets mapped to a company a

- $W_i$: Weight of asset i in company's asset portfolio, based on assumed value

- $D_j$: Aggregate dependency score of asset i

Companies evaluated using asset level data are categorized as Data Quality: "Asset-level analysis".

*Table 6: Example Assumed Asset Values per Asset Type*

| Asset Type | Assumed Asset Value ($US Million) |
|---|---|
| Light Manufacturing - Owner/Occupier (Urban) | 150 |
| Cement Manufacturing - Owner/Occupier (Urban) | 150 |
| Power Generation (General) - Owner/Operator | 1,200 |
| Natural Gas-Fired Power Plant - Owner/Operator | 640 |
| Data Center - Owner/Occupier | 300 |
| Hotel - Owner/Occupier (Urban) | 75 |
| Office - Owner/Occupier | 25 |

Source: S&P Global Sustainable1

**Impact metrics aggregation**

Tier 1 Application

Where asset-level information is not available, country and sector metrics are aggregated as follows:

- Absolute metrics, such as land use, Ecosystem Integrity Footprint, Ecosystem Footprint and overlap with KBAs/PAs are summed up across country and sector.

$$Impact_{a} = \sum_{i=1,\ j=1}^{n,m} I_{i,j}$$

Where:

- $Impact_a$: Absolute impact metric of company a

- n: Number of countries company a operates in

- m: Number of sector j company a operates in

- $I_{i,j}$: Absolute impact metric of company a in country i and sector j

- Relative metrics, such as all Ecosystem Integrity Index-related and significance index-related metrics are calculated as the weighted average of each country and sector relevant index, where weights are based on:
  - Land use for ecosystem integrity-related index metrics
  - Ecosystem Integrity Footprint for significance-related index metrics

$$Impact_{a} = \sum_{i=1,\ j=1}^{n,m} \left(W_{i,j} * I_{i,j}\right)$$

Where:

- $Impact_a$: Relative impact metric of company a

- n: Number of countries company a operates in

- m: Number of sector j company a operates in

- $W_{i,j}$: Weight of country i and sector j in company a's land use (for ecosystem integrity-related index) or Ecosystem Integrity Footprint (for ecosystem significance index)

- $I_{i,j}$: Absolute impact metric of company a in country i and sector j

Companies evaluated using company-level data are categorized as Data Quality: "Company-level analysis".

Tier 2 application

Where asset-level information is available and sufficient, asset-level metrics are aggregated as follows:

- Absolute metrics, such as land use, Ecosystem Integrity Footprint, Ecosystem Footprint and overlap with KBAs/PAs are summed up across assets

$$Impact_{a} = \sum_{i=1}^{n} I_i$$

Where:

- $Impact_a$: Absolute impact metric of company a

- n: Number of assets mapped to company a

- $I_i$: Absolute impact metric of asset i

- Relative metrics, such as all Ecosystem Integrity Index-related and significance index-related metrics are calculated as the weighted average of each asset's relevant index, where weights are based on:
    - Land use for ecosystem integrity-related index metrics
    - Ecosystem Integrity Footprint for significance-related index metrics

$$Impact_{a} = \sum_{i=1}^{n} (W_i * I_i)$$

Where:

- $Impact_a$: Relative impact metric of company a

- n: Number of assets mapped to company a

- $W_i$: Weight of asset i in company a's land use (for ecosystem integrity-related index) or Ecosystem Integrity Footprint (for ecosystem significance index)

- $I_i$: Absolute impact metric of company a in country i and sector j

Companies evaluated using asset level data are categorized as Data Quality: "Asset-level analysis".

**Tier 1 versus Tier 2 method**

Due to asset-level data coverage limitations, it is sometimes not recommended to use the Tier 2 approach if the asset coverage is not representative of a company's business. The asset-based method is therefore checked against the Tier 1, top-down, method to discard outliers and values likely not representative. For any company:

If the land use impact value calculated under the Tier 2 approach is greater than 25% of the land use impact calculated under the Tier 1 approach, the Tier 2, asset-based, value is retained, and all impact and dependency metrics are calculated under the Tier 2 approach. Companies evaluated using this method are categorized as Data Quality: "Asset-level analysis".

If the land use impact value calculated under the Tier 2 approach is less than 25% of the land use impact calculated under the Tier 1 approach, the Tier 1, top-down, value is retained, and all impact and dependency metrics are calculated under the Tier 1 approach (except overlap with KBAs and PAs metrics). Companies evaluated using this method are categorized as Data Quality: "Company-level analysis".

If the land use impact value cannot be calculated under the Tier 1 approach (due to data limitations), but asset-level information is available, the Tier 2, asset-based, value is retained and all impact and dependency metrics are calculated under the Tier 2 approach. Companies evaluated using this method are categorized as Data Quality: "Asset-level analysis - Uncalibrated".

# Limitations

1. Modelling uncertainty

S&P Global Sustainable1's Nature & Biodiversity Risk dataset and the methodologies underpinning the analysis are complex and subject to uncertainty. To mitigate this uncertainty, S&P Global Sustainable1 has ensured to use the best and most up-to-date data available.

2. Risk score instead of financial impact

The current assessment does not quantify the probability of a risk event happening, nor the actual monetary loss should such event materialise. It is therefore not a financial risk metric providing a monetary value at risk. This would require further development, in particular towards developing impact functions to quantify the monetary impact on a company's business model.

3. Potential impact instead of actual impact

Due to the lack of disclosures from companies, the methodology provides an assessment of the likely impact in each location. While it is a realistic evaluation of the expected impact, it does not constitute an actual "on the ground" evaluation.

4. Point in time assessment

The assessment is a point-in-time evaluation and is only as up to date as the underlying input data. Conversely, while the data is as recent as possible, the methodology does not account for the history of pressures in each location. Therefore, the characteristic EII footprinting approach allocates the full impact to the activity currently taking place in a given location, even if pressures started in the past. Having said that, the data provides a baseline from which it is possible to track progress going forward, and the input data will be updated regularly to incorporate the most recent and up-to-date datasets.

5. Asset location and extent uncertainty

S&P Global Sustainable1's Nature & Biodiversity Risk dataset incorporates a range of asset location datasets, some of which are actively managed and updated regularly, whereas others are updated less frequently. Consequently, it is possible that the database does not reflect changes in asset ownership and activity that have occurred in the recent past. S&P Global Sustainable1 has sought to mitigate this uncertainty by limiting data sourced from historical datasets to the past three years.

The actual extent of these assets is also estimated when actual boundaries are not available, therefore introducing uncertainty in the assessment.

6. Company Asset Coverage

It is not currently possible to determine what proportion of a company's material asset locations that are covered in the S&P Global asset database for most sectors. S&P Global Sustainable1 is exploring opportunities to calculate or estimate an asset level coverage confidence measure for future releases.

7. Spatial Resolution

The global nature and biodiversity dataset and models vary in scale, from 1km2 for the most part to 5km2, while most assets are much smaller. This creates uncertainty, in particular in impact modelling. S&P Global Sustainable1 is exploring opportunities to improve the resolution of both nature and asset data.

8. Lack of coverage

The dataset only covers impacts on terrestrial ecosystems and does not assess impacts on freshwater and marine ecosystems. This will be the subject of further enhancements.

9. Data robustness

While S&P Global Sustainable1 has ensured to use the most up-to-date, scientifically endorsed, and relevant datasets to quantify each dimension of biodiversity and ecosystems, proxy data must be used in order to provide a globally consistent assessment.

10. Abstraction and simplification

Nature and biodiversity issues are complex and cover a large array of processes. To reduce this complexity and allow a non-specialist audience to use the dataset, a significant number of datasets and indicators of different scales have been translated into scores, indices, or conceptual metrics. To deal with these limitations, S&P Global Sustainable1 has used the most appropriate mathematical tools to combine and aggregate these indicators.

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Samantha L.L. Hill, J. F. (2022). The Ecosystem Integrity Index: a novel measure of terrestrial ecosystem integrity with global coverage. *bioRxiv*.

# Appendix 1: The Ecosystem Integrity Index

A detailed description of the Ecosystem Integrity Index is provided in (Samantha L.L. Hill, 2022). A summary 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, 2019). This index is transformed using the methods described in Beyer, et al. (Beyer, 2020) 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, 2016); (Hill, 2019). The BII is calculated using two models estimated using data taken from the PREDICTS database (Hudson, 2017). The first assesses the impact of human pressures on the total abundance of species within a community. This metric used the abundance in intact sites, Primary vegetation with minimal use intensity, as a baseline reference. 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.

Both models were projected using raster data for predictors at 1km2 resolution to output gridded maps of species abundance and composition similarity. BII is obtained from the multiplication of both projected models (Newbold et al., 2016).

## 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, 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.

# Appendix 2: Calculating a Footprint on EII

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 relevant coefficient is projected. Mean BII is then calculated within the asset footprint.

# Appendix 3: Ecosystem Services and Their Definitions

| Ecosystem Service | Ecosystem service Description | Category | Category Description |
|---|---|---|---|
| Animal-based energy | Physical labour is provided by domesticated or commercial species, including oxen, horses, donkeys, goats, and elephants. These can be grouped as draught animals, pack animals and mounts. | Direct Physical Input | Ecosystem services that are a direct physical input into a production process. |
| Bioremediation | Bioremediation is a natural process whereby living organisms such as micro-organisms, plants, algae, and some animals degrade, reduce, and/or detoxify contaminants. | Mitigates Direct Impacts | Ecosystem services that help to mitigate direct impacts associated with a production process (e.g., waste, emissions, noise). |
| Buffering and attenuation of mass flows | Buffering and attenuation of mass flows allows the transport and storage of sediment by rivers, lakes, and seas. | Protection from Disruption | Ecosystem services that provide protection from disruption to the production process. |
| Climate regulation | Global climate regulation is provided by nature through the long-term storage of carbon dioxide in soils, vegetable biomass, and the oceans. At a regional level, the climate is regulated by ocean currents and winds while, at local and micro-levels, vegetation can modify temperatures, humidity, and wind speeds. | Protection from Disruption | Ecosystem services that provide protection from disruption to the production process. |
| Dilution by atmosphere and ecosystems | Water, both fresh and saline, and the atmosphere can dilute the gases, fluids and solid waste produced by human activity. | Mitigates Direct Impacts | Ecosystem services that help to mitigate direct impacts associated with a production process (e.g., waste, emissions, noise). |

| | | | |
|---|---|---|---|
| Disease control | Ecosystems play important roles in regulation of diseases for human populations as well as for wild and domesticated flora and fauna. | Protection from Disruption | Ecosystem services that provide protection from disruption to the production process. |
| Fibres and other materials | Fibres and other materials from plants, algae and animals are directly used or processed for a variety of purposes. This includes wood, timber, and fibres which are not further processed, as well as material for production, such as cellulose, cotton, and dyes, and plant, animal and algal material for fodder and fertiliser use. | Direct Physical Input | Ecosystem services that are a direct physical input into a production process. |
| Filtration | Filtering, sequestering, storing, and accumulating pollutants is carried out by a range of organisms including, algae, animals, microorganisms, and vascular and non-vascular plants. | Mitigates Direct Impacts | Ecosystem services that help to mitigate direct impacts associated with a production process (e.g., waste, emissions, noise). |
| Flood and storm protection | Flood and storm protection is provided by the sheltering, buffering and attenuating effects of natural and planted vegetation. | Protection from Disruption | Ecosystem services that provide protection from disruption to the production process. |
| Genetic materials | Genetic material is understood to be deoxyribonucleic acid (DNA) and all biota including plants, animals, and algae. | Direct Physical Input | Ecosystem services that are a direct physical input into a production process. |
| Ground water | Groundwater is water stored underground in aquifers made of permeable rocks, soil, and sand. The water that contributes to groundwater sources originates from rainfall, snow melts and water flow from natural freshwater resources. | Direct Physical Input | Ecosystem services that are a direct physical input into a production process. |
| Maintain nursery habitats | Nurseries are habitats that make a significantly high contribution to the reproduction of individuals from a particular species, where juveniles occur at higher densities, avoid predation more | Enables Production Process | Ecosystem services that are an enabling factor for all or part of a production process. |

| | | | |
|---|---|---|---|
| | successfully, or grow faster than in other habitats. | | |
| Mass stabilisation and erosion control | Mass stabilisation and erosion control is delivered through vegetation cover protected and stabilising terrestrial, coastal and marine ecosystems, coastal wetlands, and dunes. Vegetation on slopes also prevents avalanches and landslides, and mangroves, sea grass and macroalgae provide erosion protection of coasts and sediments. | Protection from Disruption | Ecosystem services that provide protection from disruption to the production process. |
| Mediation of sensory impacts | Vegetation is the main (natural) barrier used to reduce noise and light pollution, limiting the impact it can have on human health and the environment. | Mitigates Direct Impacts | Ecosystem services that help to mitigate direct impacts associated with a production process (e.g., waste, emissions, noise). |
| Pest control | Pest control and invasive alien species management is provided through direct introduction and maintenance of populations of the predators of the pest or the invasive species, landscaping areas to encourage habitats for pest reduction, and the manufacture of a family of natural biocides based on natural toxins to pests. | Protection from Disruption | Ecosystem services that provide protection from disruption to the production process. |
| Pollination | Pollination services are provided by three main mechanisms: animals, water, and wind. The majority of plants depend to some extent on animals that act as vectors, or pollinators, to perform the transfer of pollen. | Enables Production Process | Ecosystem services that are an enabling factor for all or part of a production process. |
| Soil quality | Soil quality is provided through weathering processes, which maintain bio-geochemical conditions of soils including fertility and soil structure, and decomposition and fixing processes, which enables nitrogen fixing, nitrification and mineralisation of dead organic material. | Enables Production Process | Ecosystem services that are an enabling factor for all or part of a production process. |
| Surface water | Surface water is provided through freshwater resources from collected precipitation and water flow from natural sources. | Direct Physical Input | Ecosystem services that are a direct physical input into a production process. |

| | | | |
|---|---|---|---|
| Ventilation | Ventilation provided by natural or planted vegetation is vital for good indoor air quality and without it there are long term health implications for building occupants due to the build-up of volatile organic compounds (VOCs), airborne bacteria and moulds. | Enables Production Process | Ecosystem services that are an enabling factor for all or part of a production process. |
| Water flow maintenance | The hydrological cycle, also called water cycle or hydrologic cycle, is the system that enables circulation of water through the Earth's atmosphere, land, and oceans. The hydrological cycle is responsible for recharge of groundwater sources (i.e., aquifers) and maintenance of surface water flows. | Enables Production Process | Ecosystem services that are an enabling factor for all or part of a production process. |
| Water quality | Water quality is provided by maintaining the chemical condition of freshwaters, including rivers, streams, lakes, and ground water sources, and salt waters to ensure favourable living conditions for biota. | Enables Production Process | Ecosystem services that are an enabling factor for all or part of a production process. |

# Appendix 4: Ecosystem Services and How They Are Treated in the Methodology

| Ecosystem service | Category | Sub-category | Materiality | Spatial Relevance | Spatial scale of assessment | Spatial Resilience | Spatial scale of assessment |
|---|---|---|---|---|---|---|---|
| Animal-based energy | Direct physical input | Provisioning services | Yes | No | NA | No | N/A |
| Fibres and other materials | Direct physical input | Provisioning services | Yes | No | NA | No | Global |
| Genetic materials | Direct physical input | Provisioning services | Yes | No | NA | No | Global |
| Ground water | Direct physical input | Provisioning services | Yes | No | NA | Yes | Basin scale |
| Surface water | Direct physical input | Provisioning services | Yes | No | NA | Yes | Basin scale |
| Bioremediation | Mitigates direct impacts | Regulatory & maintenance services | Yes | No | NA | Yes | Local |
| Buffering and attenuation of mass flows | Protection from disruption | Regulatory & maintenance services | Yes | Yes | Local | Yes | Landscape scale |
| Climate regulation | Protection from disruption | Regulatory & maintenance services | Yes | No | NA | Yes | Local and landscape |
| Dilution by atmosphere and ecosystems | Mitigates direct impacts | Regulatory & maintenance services | Yes | No | NA | Yes | Landscape scale |
| Disease control | Protection from disruption | Regulatory & maintenance services | Yes | No | NA | No | Global |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Filtration | Mitigates direct impacts | Regulatory & maintenance services | Yes | No | NA | Yes | Local and landscape |
| Flood and storm protection | Protection from disruption | Regulatory & maintenance services | Yes | Yes | Local | Yes | Local and landscape |
| Maintain nursery habitats | Enables production process | Regulatory & maintenance services | Yes | No | NA | Yes | Landscape scale |
| Mass stabilisation and erosion control | Protection from disruption | Regulatory & maintenance services | Yes | Yes | Local | Yes | Local and landscape |
| Mediation of sensory impacts | Mitigates direct impacts | Regulatory & maintenance services | Yes | No | NA | Yes | Local scale |
| Pest control | Protection from disruption | Regulatory & maintenance services | Yes | No | NA | Yes | Local and landscape |
| Pollination | Enables production process | Regulatory & maintenance services | Yes | No | NA | Yes | Local and landscape |
| Soil quality | Enables production process | Regulatory & maintenance services | Yes | No | NA | Yes | Local |
| Ventilation | Enables production process | Regulatory & maintenance services | Yes | No | NA | No | N/A |
| Water flow maintenance | Enables production process | Regulatory & maintenance services | Yes | No | NA | Yes | Basin scale |
| Water quality | Enables production process | Regulatory & maintenance services | Yes | No | NA | Yes | Basin scale |

# Appendix 5: Methods and Inputs for the Calculation of Dependency Metrics

1. Provisioning services

1.1 Animal-based energy

No geo-specific assessment is made as animals can be transported from one area to another.

1.2 Fibres and other materials

No geo-specific assessment is made as resources can be transported from one area to another.

1.3 Genetic materials

No geo-specific assessment is made as resources can be transported from one area to another.

1.4 Ground and surface water

While reliance on water for industrial and production processes is not driven by the location, its availability is hugely location specific. Water scarcity and water stress can significantly impact a company through process disruption or increased operating costs. The resilience risk score of water provisioning services is quantified using the S&P Global Sustainable1 Physical Risk Water Stress Index for the 2020 decade at the basin level (HydroSHEDS Level 7), calculated from the WRI Aqueduct Water Scarcity Score[15].

2. Regulating and maintenance services

2.1 Bioremediation

While reliance on bioremediation is not driven by the location, its provision is strongly correlated with the integrity of the ecosystem considered. The indicator used for the resilience risk score is the Ecosystem Impact Index at the asset location (asset polygon).

[15] World Resources Institute, Aqueduct Tools available at: https://www.wri.org/aqueduct

### 2.2 Buffering and attenuation of mass flows

The actual benefit gained from this service is variable depending on location. Therefore, the location-specific relevance score is assessed using landslide susceptibility at an asset location as the indicator, from Stanley and Kirschbaum (2017)[16].

The resilience risk is assessed using the Ecosystem Impact Index average value over the relevant water basin (HydroSHEDS Level7).

### 2.3 Climate regulation

While reliance on climate regulation is not assessed locally, the resilience risk is assessed using the Ecosystem Integrity Impact Index average value over 10 km2 around an asset location.

### 2.4 Dilution by atmosphere and ecosystems

While reliance on atmosphere and ecosystems to dilute pollutants is not assessed locally, the resilience risk is assessed using the Ecosystem Integrity Impact Index average value over 10 km2 around an asset location.

### 2.5 Disease control

No local or landscape scale assessment is used to assess this service.

### 2.6 Filtration

While reliance on organisms to filtrate pollutants is not assessed locally, the resilience risk is assessed using the Ecosystem Integrity Impact Index average value over 10 km2 around an asset location.

### 2.7 Flood and storm protection

The benefit driven from flood and storm protection depends significantly on the actual location of an activity. The relevance score is assessed using the maximum of the Sustainable1 Climate Physical Risk scores for a) Fluvial flood risk and for b) Coastal flood risk at the asset location.

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[16] Stanley, T., and D. B. Kirschbaum. 2017. "A heuristic approach to global landslide susceptibility mapping." Natural Hazards, 1-20. doi: 10.1007/s11069-017-2757-y.

The resilience risk is assessed using the Ecosystem Integrity Impact Index average value over 10 km2 around an asset location.

### 2.8 Maintain nursery habitat

While reliance on maintaining nursery habitat is not assessed locally, the resilience risk is assessed using the Ecosystem Integrity Impact Index average value over 10 km2 around an asset location.

### 2.9 Mass stabilisation and erosion control

The benefit driven from mass stabilisation and erosion control depends significantly on the actual location of an activity. The relevance score is assessed using the Global Soil Erosion Modelling Platform (GloSEM)[17] data, normalised into a score from 0 to 1.

The resilience risk is assessed using the Ecosystem Impact Index average value over the relevant water basin (HydroSHEDS Level7).

### 2.10 Mediation of sensory impacts

While reliance on mediation of sensory impacts is not assessed locally, the resilience risk is assessed using the Ecosystem Integrity Impact Index average value at an asset location.

### 2.11 Pest control

While reliance on ecosystems to control pest is not assessed locally, the resilience risk is assessed using the Ecosystem Integrity Impact Index average value over 10 km2 around an asset location.

### 2.12 Pollination

While reliance on pollination services is not assessed locally, the resilience risk is assessed using the Ecosystem Integrity Impact Index average value over 10 km2 around an asset location.

[17] Global Soil Erosion Modelling platform (GloSEM), accessible here: https://esdac.jrc.ec.europa.eu/content/global-soil-erosion

## 2.13 Soil quality

While reliance on soil quality is not assessed locally, the resilience risk is assessed using data on soil salinity from Ivushkin et al. (2019)[18] and organic carbon content from the Global Soil Organic Carbon Map (GSOC Map)[19]. Each dataset is normalised into an index from 0 to 1, and then the maximum of a) soil salinity, b) organic carbon and c) Ecosystem Integrity Impact Index is taken at a given asset location.

## 2.14 Ventilation

No local or landscape scale assessment is used to assess this service.

## 2.15 Water flow maintenance

While reliance on the maintenance of water flow is not assessed locally, the resilience risk is assessed using the Ecosystem Integrity Impact Index average value over the relevant water basin (HydroSHEDS Level7).

## 2.16 Water quality

While reliance on water quality is not assessed locally, the resilience risk is assessed using the Ecosystem Integrity Impact Index average value over the relevant water basin (HydroSHEDS Level7).

[18] Konstantin Ivushkin, Harm Bartholomeus, Arnold K. Bregt, Alim Pulatov, Bas Kempen, Luis de Sousa, Global mapping of soil salinity change, Remote Sensing of Environment, Volume 231, 2019,

111260, ISSN 0034-4257, https://doi.org/10.1016/j.rse.2019.111260.

[19] Global Soil Partnership:Global Soil Organic Carbon Map, available here: https://data.apps.fao.org/glosis/?share=f-6756da2a-5c1d-4ac9-9b94-297d1f105e83

# Version History

| Version | Created by | Date |
| --- | --- | --- |
| Version 1 | Gautier Desme | 31 August 2023 |
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