Biodiversity impact and ecosystem service dependencies

Integration of dependencies using the BFFI and ENCORE

PRé
Fact-based sustainability

CREM

UN environment programme WCMC

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For thirty years PRé has been at the forefront of life cycle thinking and has built on its knowledge and experience in sustainability metrics and impact assessments to provide state of the art methods, consulting services and software tools. Internationally, leading organizations work with PRé to integrate sustainability into their product development procedures in order to create business growth and business value. PRé has an office in the Netherlands and a global partner network to support large international or multi-client projects.

About CREM

With the limits of the planet being increasingly stressed and social challenges growing, CREM is committed to a sustainable economy and society, together with companies, governments, NGOs, academia and citizens. Sustainability is often first aimed at the frontrunners in the field, but everyone can recognize the challenges and solutions. CREM offers a wide range of services in the field of sustainable development, from brainstorming, research and strategy development to training, implementation and evaluation the results.

About UNEP-WCMC

The UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) works with scientists and policy makers worldwide to place biodiversity at the heart of environment and development decision-making to enable enlightened choices for people and the planet. Our 100-strong international team are recognised leaders in their field and have unrivalled understanding of the institutional landscape surrounding biodiversity policy and ecosystem management. Based in Cambridge, UK, UNEP-WCMC is a collaboration between UN Environment Programme and the UK charity, WCMC.

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Executive summary

Global biodiversity is decreasing at an alarming rate. Biodiversity underpins the ecosystem services we rely on. We must reduce our impact on biodiversity because it is the foundation of our soils, our water cycle and our food system. Furthermore, nature provides numerous natural raw materials, medicinal resources, and energy, which are vital for our society. All these services offered by nature are called ecosystem services and we depend on them every day.

There is a growing awareness for biodiversity and ecosystem services since the publication of the IPBES report, the report from the DNB and PBL and The Dasgupta Review. The financial community has an active role to play in this respect because of their role in our economy. There is a growing need for reliable data on biodiversity impact, and on dependencies of ecosystem services. So far biodiversity footprinting was limited to measuring impact, and assessments of dependencies did not include impact on the biodiversity that is the foundation of ecosystem services.

In this project, we combined the world of biodiversity footprinting with the BFFI (biodiversity footprint for financial institutions) and the assessment of ecosystem services with the ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure) database. By combining impact data and dependency data, financial institutions can get a better understanding of their relationship with nature.

The project has shown that the integration of dependencies in the BFFI, using the dependency data from the ENCORE knowledge base is possible. It results in an overview of the number of ecosystem services a company depends on, the type of ecosystem services involved, and their materiality and a weighted materiality based on the contribution of these ecosystem services to the sales of a company. We tested the method on the 25 companies in the AEX index, a free float market capitalization weighted index that reflects the performance of the 25 largest and most actively traded shares listed on Euronext Amsterdam.

With a biodiversity footprint, companies and financial institutions can assess the impact they have on biodiversity. Minimising the impact will reduce biodiversity loss and the risk associated with high impact operations. Different types of risks are associated with dependencies on ecosystem services. Combining a biodiversity footprint and an ecosystem services dependencies profile shows two different sides of our relationship with nature: our impact and our dependency. If you know your impact, you can reduce it. If you know on which ecosystem services a company relies, you can investigate if the ecosystem service is under treat and if it can become a risk for your operations.

The following recommendations follow from this first assessment. We have now assessed direct dependencies; the next step is to include indirect dependencies. Following the initial test with the AEX index, we can now perform this analysis in a dependency assessment of an actual investment portfolio. Furthermore, the availability and use of data on the state of ecosystem services should be explored, to better assess the risks associated with a dependency on ecosystem services. Also, the availability and use of data on production locations and supply chains. Finally, the financial industry should work towards a standardised approach for biodiversity/ecosystem services dependency assessments.

1 Introduction

1.1 Policy context

There is a growing awareness that financial institutions play a key role in conserving biodiversity and reaching the targets of the Convention on Biological Diversity. In the first common ground paper published by the Partnership for Biodiversity Accounting Financial institutions (PBAF) in September 2020, Humberto Delgado Rosa, Director for Natural Capital at DG Environment of the European Commission states:

“As a key pillar of the European Green Deal, the European Commission has adopted the EU Biodiversity Strategy for 2030 as a comprehensive, ambitious and long-term plan for protecting nature and reversing the degradation of ecosystems. It states clearly that biodiversity considerations need to be better integrated into public and business decision-making at all levels. Complementing the management accounting systems through measuring and integrating the value of nature and developing a holistic approach that includes biodiversity impact is a key enabler to achieve this. In line with the European Green Deal, the Commission is now considering actions to deliver the strategy for green financing, including the improvement of the reporting and comparability of sustainability performance data and the underlying environmental and social accounting practices.”

This growing awareness of the importance of biodiversity and the ecosystem service it provides has resulted in a wide range of initiatives, like the Partnership for Biodiversity Accounting Financials (PBAF), Taskforce on Nature Related Financial Disclosure (TNFD) and the Finance for Biodiversity Pledge. These initiatives have highlighted the role of the finance sector, including both negative and positive actions currently underway, and what needs to change in order for our global economy to move towards being nature-positive.

The Dutch government, through the Dutch Ministry of Agriculture, Nature and Food Quality, cooperates with the Dutch financial sector to accelerate the transition towards a ‘green’ financial system. Not just by creating the financial means if needed, but especially by combining knowledge and networks, building support within government, and creating access to international platforms.

At the same time, it is also clear that the financial sector is just starting to touch upon the topic of biodiversity and the majority of financial institutions is still exploring the business case of managing biodiversity impacts and dependencies. It is against this background that this project is executed.

1.2 The BFFI: from impact assessment to dependency risks

The Biodiversity Footprint Financial Institutions (BFFI), developed by ASN bank, PRé Sustainability and CREM, can be used by financial institutions to calculate a biodiversity footprint on the level of an investment portfolio, an asset class (e.g. mortgages), a project and company. The impact assessment approach of the BFFI is shared with other financial institutions, both nationally and internationally.

The BFFI footprinting methodology is continuously being improved. Not only by integrating updates of the underlying impact models (like ReCiPe) and databases (e.g. EXIOBASE, ecoinvent), but also by research into methodological issues, like the inclusion of impact drivers not yet (fully) covered by the BFFI (like overexploitation) and the integration of the positive impact of certification standards (like FSC, MSC, ASC, RSPO).

An important next step in the improvement of the BFFI is the integration of dependencies on ecosystem services. Integration of dependencies will result in a tool which not only provides a biodiversity impact score & profile, but also an ecosystem services dependency score & profile. The extra value to financial institutions is obvious: the BFFI will not only show where the biodiversity impact hot spots are located in an investment portfolio, but also where dependency hotspots are located.

1.3 About this document

This document was written to explain the findings in our journey to include dependencies on ecosystem services in the BFFI. The lessons can be used by financial institutions who are looking for ways to assess their biodiversity footprint and dependencies on ecosystem services. Researchers and methodology developers can also use this work to expand their methodologies. Some of the recommendations are addressed to all parties involved in mainstreaming and standardizing biodiversity footprinting and the assessment of ecosystems services dependencies. This includes companies, financial institutions, policy makers and non-governmental organisations.

This methodology document describes our main findings in the project to expand the BFFI with an ecosystem services dependency assessment. We started with identifying the data needed to include dependencies on ecosystems services in a biodiversity footprint. The results are described in chapter 2. In chapter 3, the method to calculate biodiversity impact and to determine the dependencies on ecosystems services is explained using an example of a multinational steel manufacturer. In chapter 4, the methodology is tested by calculating impact scores and dependency profiles for all companies in the Amsterdam Stock Exchange (AEX index). In chapter 5, the following main conclusions and recommendations are summarized:

- The integration of dependencies in the BFFI, using the dependency data from the ENCORE knowledge base is possible.
- The method should be further tested in a dependency assessment of an actual investment portfolio.
- The next step is the integration of indirect dependencies.
- The availability and use of data on the state of ecosystem services should be further explored
- More detailed data on production locations and supply chains is needed for more precise biodiversity footprints and more precise ecosystem service dependency profiles
- More effort is needed to develop a standardised approach for biodiversity/ecosystem services dependency assessments.

2 Data for dependencies on ecosystem services

The intention of integrating dependencies on ecosystem services in the BFFI method for biodiversity impact assessment, is to develop a method which not only provides a biodiversity impact score & profile, but also an ecosystem services dependency score & profile. The extra value to financial institutions is obvious: the BFFI will not only show where the biodiversity impact hotspots are located in an investment portfolio, but also where in the investment portfolio dependency hotspots are located.

Recent research by the Dutch Central Bank (DNB) and PBL Netherlands Environmental Assessment Agency has shown that the dependency on ecosystem services like pollination may indeed pose a significant risk to the Dutch financial sector ('Indebted to nature; Exploring biodiversity risks for the Dutch financial sector', June 2020). The DNB/PBL research used sector-specific dependency data from the ENCORE knowledge base, developed by the Natural Capital Finance Alliance ('NCFA'; consisting of Global Canopy, UNEP Finance Initiative, UNEP-WCMC).

To make the integration of dependencies in the BFFI a reality, an analysis is made of the data need and data availability and the ways in which these data can be added to the BFFI methodology. The resulting method has been piloted by calculating a biodiversity impact and dependencies score of the 25 constituents of the AEX index. This index includes stocks of 25 companies with the biggest market capitalization on the Amsterdam stock exchange.

2.1 Data need

In order to understand what data are needed for the BFFI to deliver a dependency profile, it must be clear how impact assessment by the BFFI works. This is explained in the following steps:

Step 1: Understand the investment
Each investment in a business, organization or project needs to be defined in terms of the economic activities linked to the investment. This can be quite straightforward, e.g. in case of an investment in a mining or agricultural company, but can also be more challenging, e.g. in case of an investment in a company producing a wide range of products or services.

Data: Publicly available company data can be used to understand the investment. Companies report their revenue and the sectors and regions where the revenue is made in their annual reports and their financial statements. For example, for the 25 constituents of the AEX index, we use data from the Euronext website, and from annual reports.

Publicly available revenue data is also available through financial data providers, (e.g., Refinitiv, Bloomberg or Factset). The main advantage of using the data from these data providers is that they have structured the revenue data by region and sector allowing for automated calculation of biodiversity footprints. The main disadvantage is that the structured data is not publicly available and can only be accessed through subscriptions from the data providers.

For more detailed company specific calculations, detailed data on procurement can be used. Since this information can be competitively sensitive this can only be done when the impact assessment is commissioned by the companies themselves.

In practice, data on the supply chains of companies are often lacking. If this is the case, databases providing data on trade-flows between sectors and countries can be used to model the 'average' supply chains for a company in a specific sector. The BFFI uses the EXIOBASE database for this purpose.

Step 2: Assess environmental inputs & outputs
For the economic activities invested in, the environmental inputs (land use, resource use) and outputs (emissions) are identified.

Data: Company data (if available) or background data from databases (often sector averages) like EXIOBASE or ecoinvent.

The footprint will be more accurate if company data can be used. However, in practice, company data are not always available (this is especially true for environmental data in supply chains) and/or the use of company data is not feasible due to the number of companies involved. For example, a footprint on a portfolio level may involve hundreds of investees and thousands of (sub)suppliers.

Step 3: Assess environmental pressures and the impact on biodiversity
The environmental pressures induced by the environmental inputs and outputs (like the contribution to climate change from greenhouse gas emissions) are calculated using the ReCiPe model. The impact on biodiversity resulting from these environmental pressures is calculated using the same model.

Pressures included in the quantified footprint include:

- Climate Change
- Land use (change)
- Terrestrial Acidification
- Terrestrial Eutrophication
- Photochemical Ozone Formation
- Terrestrial Ecotoxicity
- Water Use
- Freshwater Eutrophication
- Freshwater Ecotoxicity
- Marine Eutrophication
- Marine Ecotoxicity

Pressures which cannot be included (e.g., invasive species and overexploitation) in the calculation are covered in the qualitative analysis in step 4.

Data: The environmental inputs and outputs identified in step 2.

The ReCiPe model is one of the pressure-impact models used internationally to assess the potential impact on biodiversity of environmental pressures. The model is based on scientific studies and was developed by an international consortium involving RIVM, Radboud University, Trondheim University and PRé Sustainability. The model calculates the percentage of species lost in a certain area, during a certain period: PDF.ha.yr (PDF = 'Potentially Disappeared Fraction of species').

ReCiPe includes pressure-impact relationships for emissions and resources and the environmental pressures listed above. For climate change for example, the pressure impact relationship of 190 different greenhouse gasses is included, based on their global warming potential. The expected temperature increase and the expected result on the potentially disappeared fraction of species allows a calculation of the potential impact on biodiversity resulting from the emission of greenhouse gasses.

For land use, by default six types of land occupation are included in ReCiPe: used forest, pasture and meadow, annual crops, permanent crops, mosaic agriculture and artificial areas. More detailed land use modelling can be added when more specific information on land use types is available.

The limitation of the six land use types becomes clear when, for example, analysing the impact for agroforestry. Should agroforestry be classified as 'used forest' or 'permanent crops'? A solution for this dilemma is to develop specific characterisation factors for agroforestry and the different land use practises possible. In the example of agroforestry, limited land use impacts on biodiversity are expected when a few coffee plants are placed in an otherwise undisturbed forest. Major land use impacts on biodiversity are expected when a few trees are planted in a monoculture of coffee plants. Since the ReCiPe methodology is transparent and well documented, adding pressure impact relationships is possible when sufficient scientific research is available.

Step 4: Interpret the results and take action

The results of the footprint calculation are analysed and interpreted in step 4, taking into account the limitations of the calculations. Limitations can be related to the data used (e.g. the use of sector average data instead of company data) and to the characteristics of the ReCiPe model (e.g. the impact of invasive species is not yet covered by the model). The relevance and significance of these limitations is assessed by means of a qualitative analysis, looking at the sectors/companies/projects invested in and the intended use of the footprint.

Linking dependency data to the BFFI approach

In order to link sector or production process specific dependency data to an investment, it must be clear what sectors and production processes are linked to the investment. In the first step of the BFFI, investments are translated into sectors directly or indirectly linked to this investment, including the countries in which these sectors are located. Different approaches are used, depending on the type of investment, for example:

- Equity
  For investments in equity, company revenue data per sector and region in which the revenue is generated. These data can be collected from company publications, index

websites, or financial data providers. Revenue data are used to translate an investment in a specific company into sectors directly linked to this investment, including the countries in which these sectors are located. Sectors supplying to the sectors identified, including the countries where these sectors are located, are identified using EXIOBASE data on trade flows between sectors and countries.

- Government bonds
  Country specific data on government spending are used to link a government bond to sectors directly involved, followed by the same step as in equity, i.e. using EXIOBASE to map the sectors and countries in the supply chains.
- Mortgages
  In case of mortgages, the sector invested in is housing and the impact on biodiversity is calculated based on the land use and energy use of the houses for which a mortgage is provided.
- Project financing (incl. renewable energy projects)
  In case of project financing, project data are used to identify the sectors directly invested in (e.g. a wind park) and EXIOBASE data are used to identify the sectors in the supply chain (e.g. producers of wind mills).

For all asset classes this step results in an overview of sectors which are directly or indirectly linked to an investment. Depending on the data source (annual reports, index websites, or financial data providers) the overview of sectors can be standardized using sector classifications, or unstandardized when companies use their own nomenclature. In the case of unstandardized reporting, the sectors need to be manually linked to the sector classifications used by the database with dependency data. When sectors are defined by means of a NACE code (Nomenclature statistique des Activités économiques dans la Communauté Européenne) or another sector classifications, like SIC, NAIC or GICS, linking matrixes can be used to automate this step.

2.2 Data availability

The following dependency data are available from existing databases:

2.3 ENCORE knowledge base

ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure) enables users to visualise how the economy depends on nature and how environmental change creates risks for businesses (encore.naturalcapital.finance). Starting from a business sector, ecosystem service, or natural capital asset, ENCORE can be used to explore natural capital risks. The ENCORE knowledge base is developed (see
Figure 1 below) by the Natural Capital Finance Alliance (‘NCFA’; consisting of Global Canopy, UNEP Finance Initiative, UNEP-WCMC).

ENCORE offers the user a way to explore sector-specific dependencies on ecosystem services, the natural capital assets supporting the provision of these services and drivers of environmental change affecting service provision. For each natural capital asset and driver of environmental change, spatial data layers are provided to enable the exploration of location-specific risks.

ENCORE does not provide an overview of the status of the ecosystem service itself (e.g. it does not include maps of pollination services), but instead shows:

- That the production of 'agricultural products' depends on a number of enabling ecosystem services, like 'soil quality', 'water quality' and 'pollination'.
- That the ecosystem service 'pollination' depends on the natural capital assets 'atmosphere', 'species' and 'water', including a subdivision of these assets for which spatial data are publicly available. For example, 'atmosphere' is divided in 'Change in Precipitation Seasonality', 'Change in Temperature Seasonality' and 'Change in Wind Speed'.
- The drivers of environmental change potentially affecting the service, like 'droughts', 'flooding' and 'habitat modification'.
- Spatial data layers (maps) on these natural capital assets and drivers.

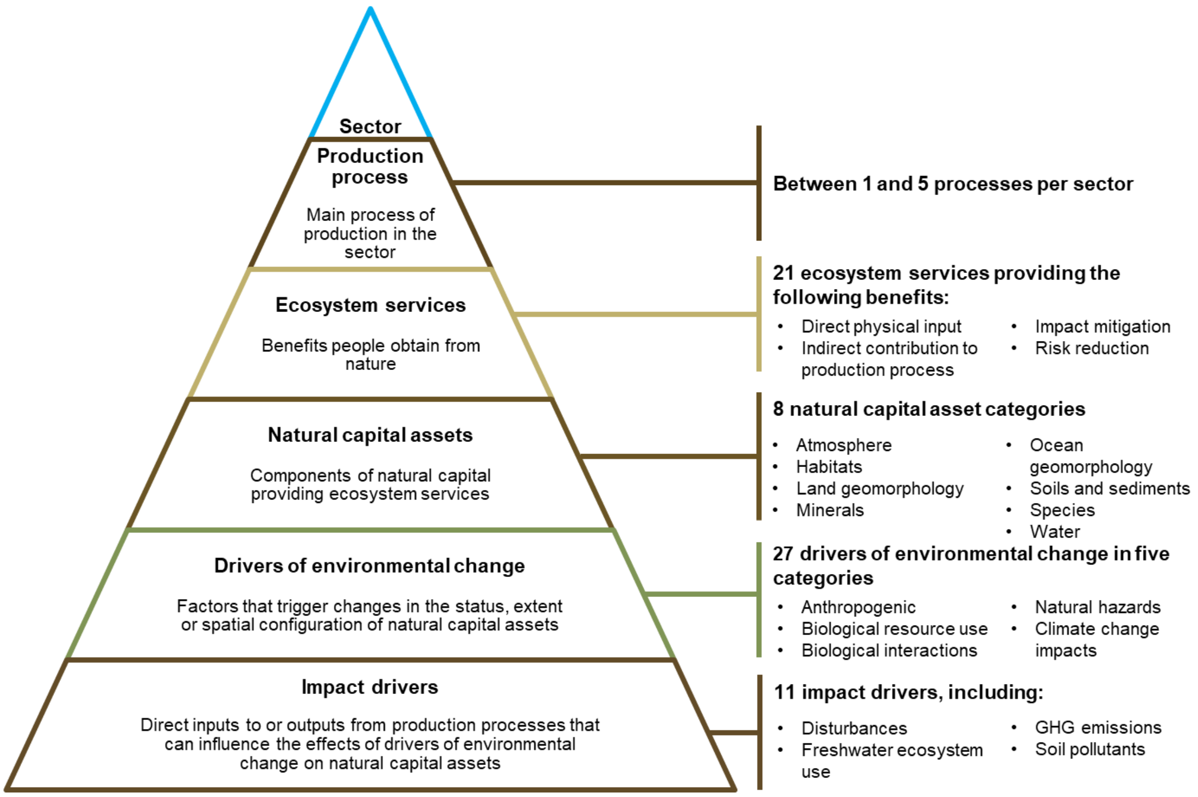


Figure 1: Conceptual framework of the ENCORE knowledge base.

Despite ENCORE bringing together a vast amount of information from the scientific and grey literature on dependencies of economic activities on natural capital, information on dependencies of economic activities on ecosystem services is still relatively poor. The database and tool are still under active development, however, companies and financial institutions can already use this information to identify natural capital related risks for all sectors.

Coverage of indirect dependencies

While the ENCORE knowledge base provides information on direct dependencies of production processes on ecosystem services, it does not currently include a supply chain view. As a result, it is not straightforward to identify indirect dependencies of production processes. For example, it is not possible to automatically identify dependencies that may occur upstream of a food and beverage company (e.g. through sourcing of commodities), or downstream (e.g. through retail outlets).

An assessment of indirect dependencies can be provided, but would require substantial additional work, including:

- Expanding the ENCORE knowledge base on direct dependencies to include indirect dependencies; this could, for example, be in the form of an environmentally extended input-output model and may require translating GICS and ENCORE production processes into a relevant industry classification;
- Determining an appropriate method for displaying indirect dependency risk to users (e.g. if/how to use financial data in the method given that most value is generated in sectors that often are less at risk from disruption to ecosystem services).

Coverage of sectors and level of detail

ENCORE classifies sectors, using the Global Industry Classification Standard (GICS):

1. Consumer Discretionary (e.g. footwear, apparel retail, etc.)
2. Consumer Staples (e.g. agricultural products, brewers)
3. Energy
4. Financials (e.g. investment banking & brokerage, asset management & custody banks, consumer finance)
5. Health Care
6. Industrials
7. Information Technology
8. Materials (e.g. commodity chemicals, construction materials)
9. Real Estate
10. Telecommunication Services
11. Utilities (e.g. renewable electricity)

Each sector is divided into sub-industries from GICS and each sub-industry (total 157) is linked to one or more production processes (total 86). The list of production processes is not part of GICS and was created when ENCORE was developed. For example, the sub-industry 'agricultural products' (part of the sector 'consumer staples') is divided into the following production processes:

- Aquaculture
- Freshwater wild-caught fish
- Large-scale irrigated arable crops
- Large-scale livestock (beef and dairy)
- Large-scale rainfed arable crops
- Saltwater wild-caught fish
- Small-scale irrigated arable crops
- Small-scale livestock (beef and dairy)
- Small-scale rainfed arable crops

Coverage of ecosystem services

ENCORE covers the following ecosystem services, based on the Common International Classification of Ecosystem Services (CICES):

1. Animal-based energy
2. Bio-remediation
3. Buffering and attenuation of mass flows
4. Climate regulation
5. Dilution by atmosphere and ecosystems
6. Disease control
7. Fibres and other materials
8. Filtration
9. Flood and storm protection
10. Genetic materials
11. Ground water
12. Maintain nursery habitats
13. Mass stabilisation and erosion control
14. Mediation of sensory impacts
15. Pest control
16. Pollination
17. Soil quality
18. Surface water
19. Ventilation
20. Water flow maintenance
21. Water quality

For each of these ecosystem services a description is provided. The ecosystem services are categorized according to their function:

- Direct physical input (e.g. animal-based energy, fibres and other materials)
- Protection from disruption (e.g. climate regulation, flood and storm protection)
- Mitigates direct impacts (e.g. dilution by atmosphere and ecosystems, filtration)
- Enables product process (e.g. pollination, water quality)

Linking sub industries to production processes to ecosystem services

For each production process, an overview is provided of the ecosystem services which are to some extent material to the production process. This materiality runs from very low (VL) to very high (VH). The materiality rating is based on the loss of functionality in the production process if the ecosystem service is disrupted and the accompanying financial losses.

Each level of materiality is defined. For example, a 'very high materiality rating' (VH) means: "*Ecosystem service is critical and irreplaceable in production process. Production process can take place with some disruption of the ecosystem service, but the high quantity of the ecosystem service required for the production process makes this a high risk*."

To assess the importance of an ecosystem service to a production process and the materiality of the impact if this service is disrupted, two aspects were considered:

1. How significant is the loss of functionality in the production process if the ecosystem service is disrupted? Limited, moderate, or severe?

2. How significant is the financial loss due to the loss of functionality in the production process? Limited, moderate, or severe?

The materiality assessment reflects both considerations. A very high materiality rating means that the loss of functionality is severe and that the expected financial impact is also severe.

For 'Aquaculture' the following ecosystem services are identified as very high or high materiality (presented per ecosystem services category):

- Direct physical input: Fibres and other materials
- Enables production process: Water flow maintenance, Water quality
- Protection from disruption: Climate regulation, Flood and storm protection, Mass stabilisation and erosion control

For each ecosystem service, the natural capital assets that underpin this service are listed in ENCORE. As an example, for 'Fibres and other materials' it is stated that this service depends on 'Habitats' and 'Species'. In turn, these assets are influenced by 'Drivers of environmental change'. For example, 'Habitats' are vulnerable to, among others, droughts, fire, flooding and landslides. Finally, contextual information is provided for each driver of change and the effects it can have on natural capital assets and ecosystem service provision.

Factsheets are available for each ecosystem service, describing the ecosystem service-natural capital asset system, the main drivers of environmental change influencing or impacting the system and the mechanism by which these impact ecosystem service provision.

The importance of natural capital assets to ecosystem services and the influence of drivers of environmental change on natural capital assets is characterized by a red, amber or green color. More information on this classification system can be found on the ENCORE website. Noting that "*the framework for assessing the importance of natural capital assets and influence of drivers of environmental change should be used as a general guideline*".

ENCORE was launched in 2018 and as such is still a relatively young tool. While the information provided by ENCORE is extensive, it serves primarily to *inform* users on the links between nature and the economy. However, it does not currently fit all applications by the finance sector, and it does not provide outputs that can directly *support decision-making*. As such the integration of ENCORE's dependency information within the BFFI will serve to improve the application of ENCORE's knowledge base. At the same time, it will add a dependency component to a methodology that is already used to support decision-making by financial institutions.

2.4 Use of ENCORE in the 'Indebted to nature' study

The 'Indebted to nature study of the Dutch Central Bank and PBL Netherlands Environmental Assessment Agency (the 'DNB study', June 2020), also used the ENCORE knowledge base to identify ecosystem services related risks. Only ecosystem services with high or very high dependence were included in the analysis. The exposure of the financial sector to different sectors was determined based on the statistics of holdings of equity and bond investments by pension funds, insurers and banks, and based on a database for business loans by banks.

The exposure of financial institutions to the various ecosystem services was subsequently determined in two ways:

- An unweighted allocation of exposures to each ecosystem service with high or very high dependence. This means that when investments are linked to a production process that depends on several ecosystem services, the whole investment is allocated to each service.
  This approach shows what part of an investment portfolio depends on a specific ecosystem service.
- A weighted allocation where the sum invested in a production process is equally divided over the different ecosystem services with high or very high materiality. This approach shows what part of an investment portfolio depends on one or more ecosystem services.

This approach shows for what part of the investments, the loss of ecosystem services would lead to substantial disruption of business processes and financial losses. Note that this is a conditional risk, i.e. the risk depends on the loss of the ecosystem services concerned.

A number of limitations of this methodology apply:

- The analysis only considered 'first-order' dependencies of the economic sectors on the ecosystem services; the analysis only looked at the sectors directly in vested in, which means that dependencies further up the supply chain were not included.
- The actual risk of ecosystem services being disrupted is a location specific risk and some disruptions may be adressed by mitigating measures (e.g. creating landscape elements which are attractive to animal pollinators in case of a loss of pollination services).
- The analysis omits ecosystem services with a lower materiality rating. While this helps refine the list of ecosystem services included, it does also pose the risk of missing potentially material ecosystem services.

2.5 What data can be used for integration in the BFFI?

Dependency data
The ENCORE knowledge base can be used to identify the dependencies of sectors, through the related production processes, on ecosystem services. Also looking at the way the ENCORE knowledge base is used in the DNB study, the integration of dependency data in the BFFI could look as follows:

Step	Result
Link ENCORE knowledge base on sectors - production processes - ecosystem services, based on GICS classification, to the sectors identified in step 1 of the BFFI, based on NACE classification. Like in the 'Indebted to Nature' study, this requires a crosswalk table. In the DNB study, the ecosystem services dependencies were limited to ecosystem services with a 'high' or 'very high' materiality. In this project, we decided to include all ecosystem services using a weighting system to account for the differences in materiality ratings for each production process - ecosystem service combination.	This step will result in an overview of the production processes and ecosystem services linked to the sectors identified in the BFFI. A distinction can be made between the sectors directly invested in and sectors indirectly invested in through supply chains (modeled by using the extended input-output database EXIOBASE). In this way, a risk profile can be created for 'first order' or 'direct' dependencies and 'indirect' dependencies on ecosystem services. This was not done in the scope of this project which focusses on direct dependencies first.
The method to provide a combination of a biodiversity impact and an ecosystem service dependency profile was applied to 25 companies of the AEX index. A next step could be to link the sum of investments and loans to the dependencies on ecosystem services. At the level of a portfolio.	This will result in a risk profile showing: The financial share of the portfolio which directly, indirectly or directly/indirectly depends on a specific ecosystem service. This is an unweighted score: see also the DNB study: For a business process with a dependence on, for example, the groundwater supply and pollination, one euro is allocated to the groundwater supply and one to pollination for every euro invested in that business process (DNB, 2020). For example: "20% of the portfolio depends on pollination services of high or very high materiality". The financial share of the portfolio which is directly, indirectly or directly/indirectly dependent on one or more ecosystem services. In this case, for a business process with a dependence on, for example, the groundwater supply and pollination, one euro is allocated to the groundwater supply and one to pollination for two euros invested in that business process (DNB, 2020). For example: "80% of the portfolio depends on one or more ecosystem services of high or very high materiality".

Data on the disruption of ecosystem services

The risk resulting from a dependency on an ecosystem service can be more severe, or less severe. The risk is high if the disruption of the supply of the ecosystems service is likely. The risk of low if the chances of disruption in the supply is low. There are basically two types of data which could show whether there is a material risk of disruption to ecosystem service provision:

1. Data on the provision of and trends in ecosystem services in different regions/locations.
2. Data on the availability of and trends in natural capital assets underpinning the ecosystem services.

Data on the provision of and trends in ecosystem services in different regions/locations

Data on the provision of and trends in ecosystem services in different regions/locations are still quite limited, except for water quality and quantity and a limited number of national maps, like the 'Atlas Natuurlijk Kapitaal' in the Netherlands. For water quality and quantity, maps like the 'Aqueduct Water Risk Atlas' (WRI), the Global Water Tool (WBCSD) and the Water Risk Filter (WWF) are available.

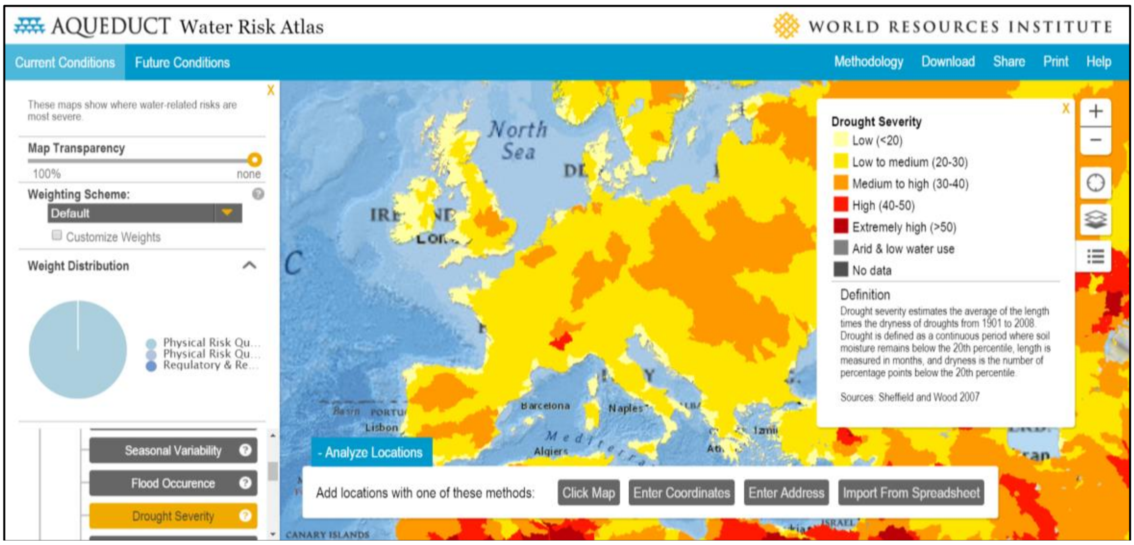


Figure 2: Drought severity in the Aqueduct Water Risk Atlas

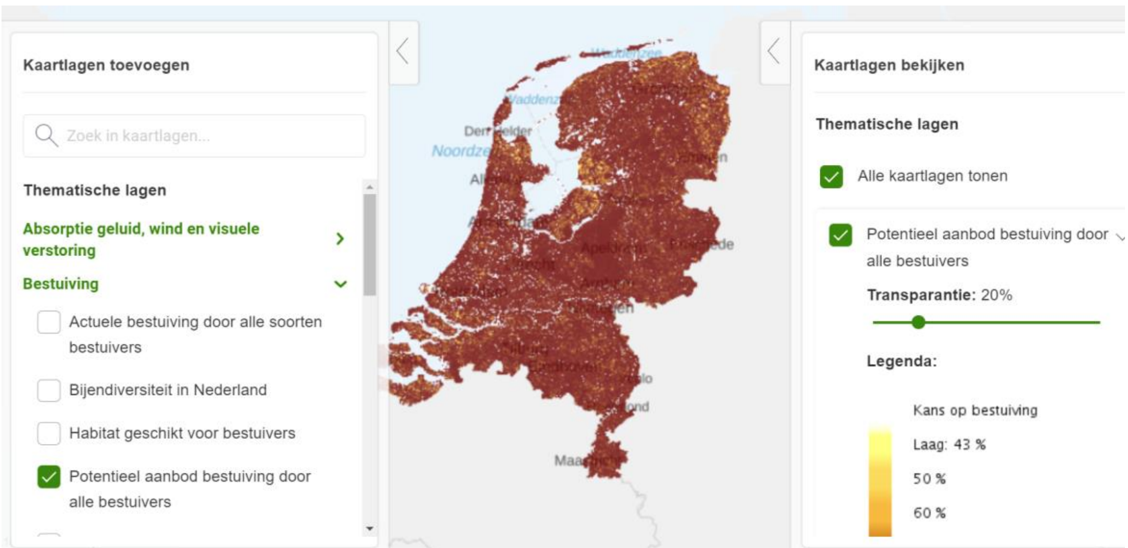


Figure 3: The Atlas Natuurlijk Kapitaal and the potential supply of pollination services by all pollinators

However, for most of the other ecosystem services, such data are not readily available. For example, for pollination services, the IPBES[1] thematic assessment notes that:

"*An obvious conclusion of our survey of the state of knowledge of status and trends in pollinators is that surprisingly little is known about them, with the exception of honey bees (Apis mellifera) and 308 some bumble bees (Bombus species) and for a few well-studied regions of the world, particularly NW-Europe and North America*." "*To assess better the status of pollinators, standardized pollinator monitoring schemes need to be implemented*."

The option to derive data on the status of ecosystem services in different regions/locations is currently being discussed with the Ecosystem Services Partnership (ESP), but this is not available yet.

Data on the availability of and trends in natural capital assets underpinning the ecosystem services

The ENCORE knowledge base looks at the potential disruption of ecosystem services through a two-step approach:

1. The natural capital assets underpinning the ecosystem services
2. The drivers of environmental change influencing these natural capital assets

The combination of the two provides an indication of the extent to which ecosystem services may be at risk. However, the relationships between the drivers of environmental change, the natural capital assets underpinning ecosystem services and the ecosystem services are complex, which could make an analysis time consuming.

UNEP-WCMC have developed maps to identify hotspots of natural capital risk. Five terrestrial maps highlight areas in the world where natural capital assets that underpin ecosystem services are being depleted (atmosphere, water, soils and sediments, and biodiversity, and one map combining all four assets). A marine map highlights areas in the world where natural capital that underpins ecosystem services is potentially being depleted due to high human pressures. These can be used to highlight potential risk to ecosystem services if their underpinning natural capital assets are being depleted. The maps could be used in future to support a more spatially refined assessment of dependency risk.

The need for data on the production location

If data on the status of and/or trends in the provision of ecosystem services is available for specific production locations, this information would still need to be combined with data on the locations where production takes place. This information may be available for companies directly invested in, but is often missing for suppliers to these companies (especially beyond first tier suppliers).

In the BFFI, supply chains are modelled using EXIOBASE data, showing what sectors and countries are part of the supply chains. If meaningful data on ecosystem services are available on a country level, this could be linked to the data on the modelled supply chains. However, since the

[1] 'Annex to document IPBES/4/INF/1/Rev.1'; Thematic assessment on pollinators, pollination and food production (deliverable 3 (a)): Individual chapters and their executive summaries', IPBES

provision of most ecosystem services can vary highly within a country, the use of country level data is expected not to be accurate enough to result in a clear and useful picture of the risks of ecosystem services disturbance. As such country-level information could only provide a high level screening for potential risk hotspots across multiple countries. This would then need to be supplemented by more detailed in-country analysis to understand dependency risk at specific production locations.

2.6 Resumé

The analysis shows that it is feasible to integrate dependencies on ecosystem services in the BFFI, building on the ENCORE knowledge base on sectors, production processes and ecosystem services and the approach taken by the Dutch Central bank and the PBL Netherlands Environmental Assessment Agency. This will result in an overview of the direct dependencies on ecosystem services for each individual investment in a portfolio showing:

- The biodiversity footprint of an investment
    - The total annual biodiversity loss
    - The annual biodiversity loss per euro revenue
    - The annual biodiversity loss per invested euro
    - Contribution analysis per driver
    - Contribution analysis per sector
- The ecosystem service dependency profile
    - The number of ecosystem services the company depends on
    - The type of ecosystem service and its materiality
    - The weighted materiality and the financial value (e.g. contribution to sales)

Other options (not included in this project) at the level of a portfolio are:
- The share of the portfolio which directly depends on a specific ecosystem service.
- The share of the portfolio which directly depends on one or more ecosystem services.
- An overview of the sector – country – ecosystem service combinations involved.

The next step of showing which of these dependencies represent an actual financial risk due to a disturbance of the ecosystem services involved may be possible for individual investments. This would require that data on production location(s) and likelihood of disruption to ecosystem services in these locations are available. On the level of an investment portfolio, this may not be feasible currently due to a lack of information (with sufficient granularity) on production locations (especially in supply chains) and a lack of information on the provision of ecosystem services in these locations. However, once this data is available this can be integrated into the dependencies methodology.

3 Integration of dependency data and output design

In this chapter, the method to calculate biodiversity impact and to determine the dependencies on ecosystems services is explained using an example of a multinational steel manufacturer. In paragraph 3.1, the biodiversity impact of the multinational steel manufacturer is calculated. In paragraph 3.2 the dependencies on ecosystem services are of the multinational steel manufacturer are determined.

3.1 Biodiversity impact of a multinational steel manufacturer.

Assessing biodiversity is far from a trivial thing, even when you are in a specific location and have time to study an area. When assessing the biodiversity footprint of multinational companies, the complexity increases because companies have complex supply chains and impact occurs on many places around the world. The life cycle assessment (LCA) methodology has been designed to model environmental impacts caused in (international) supply chains. The BFFI is using the LCA methodology to assess the biodiversity footprint of a company.

3.1.1 The approach

There are different levels of detail possible when calculating the environmental impact of a company. It can be done based on publicly available data reported by the company, or on detailed data on scope 1 inputs and emissions, scope 2 purchases of electricity and heat, and scope 3 inputs from the company supply chain. When there is sufficient time and data available, the detailed approach is preferred since the results will be more accurate. If the use case of the assessment is intended for entire investment portfolios with dozens or hundreds of different companies, the approach using publicly available revenue data is preferred. In that case the data on scope 1, 2 and 3 inputs and emissions are modelled using an environmentally extended input-output database. For this example, we make use of the approach based on publicly available data. The approach is based on four steps shown in .

1. Understanding how an investment facilitates a certain economic activity, that has impacts. For this, the investment data are analysed and often additional data need to be collected from annual reports, statistics etc.
2. The translation of economic activities into the use of resources and emissions. For this we use direct data from companies or LCA databases; this includes, among others, the use of land and water resources. In LCA terminology this is referred to as the 'inventory phase'.
3. The translation of emissions, land, water and resource use into environmental pressures as well as an assessment of how these pressures contribute to biodiversity impacts. In LCA terminology this is referred to as 'Life-Cycle Impact Assessment'.
4. Interpret the results, using both quantitative impact calculations and a qualitative analysis, and take action.

Each step is briefly explained below.

Figure 4: BFFI methodological steps.

Step 1: Understand the investment

In the first step an analysis is made of the economic activities that are linked to a specific investment. In this case, we want to know which products are made by the company and how much revenue they generate with these products. The relevant data from the annual report of our example company, and the links to the inventory data in step 2 (choice of sectors and regions) are shown in the following table.

Table 1: Company A input data for step 1

Company A	ISIN NLXXXXXXX	EXIOBASE sector/region
Market Capitalization	25 MEUR	-
Revenue	50 MEUR	-
Products:	Share of revenue (%)	
Steel product A	62	Manufacture of basic iron and steel and of ferro-alloys and first products thereof
Steel product B	19	
Iron product C	3	Manufacture of fabricated metal products, except machinery and equipment
Iron ore and coal	2	Mining of iron ores
Other	14	Manufacture of basic iron and steel and of ferro-alloys and first products thereof

Geography:	Share of revenue (%)	
Germany	8	Germany
France	6	France
Spain	5	Spain
Europe	31	Other European countries
United States	22	United States
Americas	17	Mexico, Brazil, RoW America
Aisa and Africa	11	China, India, Japan, RoW Asia, South Africa, RoW Africa

Step 2: Assess environmental inputs and outputs

The LCA community has developed a number of generic databases that list the emissions and resource use for common human activities. There are two basic types:

- The traditional LCA database that describes each human activity as a process and specifies the inputs and outputs of every process in physical units; for instance, to produce a kg of steel you need x kg of coke and y kg of ore, while you emit z kg of CO_2.
- The input output approach. These databases do not describe a specific industrial operation but average the activities in an economic sector and specify the inputs and outputs in monetary terms. In the same example: to produce one euro worth of steel, you need to purchase x dollar from the fossil fuel sector, and y dollar from the ore sector, while you produce y kg of CO_2. The data are sector averages, mostly based on statistics. One can thus not find data on a specific company as in the traditional LCA databases. In practice, we use EXIOBASE as the input output database. More information can be found on www.exiobase.eu. In this analysis, version 3.4 was used.

Both types of data have their advantages and disadvantages: traditional data can be more specific. Using traditional LCA data means that there is no need to work with the average impacts of the fossil fuel sector; instead, data that accurately specifies the impact of a specific supplier can be used. The input output database is rough, but can adequately describe a complete economy, and in our case even contains a full model of the global economy and the impact each sector has. Both types of databases produce a list with hundreds, and sometimes thousands of emissions and resource uses.

We are currently using EXIOBASE v3.4 with the base year 2011. The data is becoming increasingly outdated, and we aim to update to EXIOBASE 3.8. As of this version, the base year is 2016. For the environmental data, the end years of real data points used are: 2015 for energy, 2019 for all GHG, 2013 for material use, and 2011 for most others inputs, such as land and water.

Step 3: Assess environmental pressures and the impact on biodiversity

Once we have a list of resources and emissions, it is important to understand their meaning. Over the years many researchers developed methodologies that translate all these emissions in 10 to 20 so called 'midpoint impact categories', such a climate change, land use, water depletion, ozone layer depletion etc. Interpreting such a list of impact categories is not easy, and that is why some of these methods have been further reduced to specify the results at a higher aggregation level: the 'endpoints'. Since 1995, PRé Sustainability has been a strong promoter of this idea and has been responsible for the development of several methods, such as Eco-indicator 95, Eco indicator 99 and ReCiPe 2008. In this report we use the latest version ReCiPe 2016.

A key characteristic of the ReCiPe 2016 method is that it translates 17 impact categories into three endpoints: Human Health, Ecosystems and Resources. For this project we have excluded the impacts on human health and resources because the focus is on biodiversity.

Figure 5 provides an overview of how 10 impact categories are linked to biodiversity impacts, expressed as PDF.m^2.yr. For a description of how all these impacts influence biodiversity we refer to the ReCiPe 2016 report and the underlying peer reviewed scientific articles. In the annex we provide some more information. Since this year, the impact on biodiversity is provided for each midpoint impact category.

The unit of the "ecosystem damage" is defined as "PDF.m^2.yr" for land-based ecosystems and "PDF.m^3.yr" for water-based systems. The term PDF refers to "Potentially Disappeared Fraction of species". This means the percentage or fraction of species that are no longer found, due to a man-made impact of some kind[2]. This percentage is calculated with the surface area or water volume, and the time[3]. For impacts in ecosystems in fresh water and marine (salt) water, we cannot use the surface area, but we need to use a volume. This explains the unit PDF.m^3.yr. To translate these two units into one unit, the PDF units are divided by the average species density on one square meter land, one cubic meter fresh water and one cubic meter marine water.

[2] We typically refer to vascular plants on land and lower organisms in water and sometimes other lower organisms. These lower organisms are typically at the beginning of the food chain, and if something goes wrong there, it will have impact on the higher organisms. Modelling the disappearance of higher organisms is much more difficult, as there are many factors that determine their fate, including hunting, poaching etc.

[3] Example: If a farmer wants to produce 1 kg of corn, it needs a certain area, during a year (or half a year if there are two harvests). During that time, the number of species on the corn field is reduced. This means the damage has three elements, a potentially disappeared fraction, a surface area in m^2 and a time element, expressed in years. For a CO_2 emission this somewhat less intuitive, but one can imagine that a kg will not stay for ever in the atmosphere, which explains the time element. One kg can also not make a species disappear all over the world, so there is a limited reach, explaining the area part of the formula.

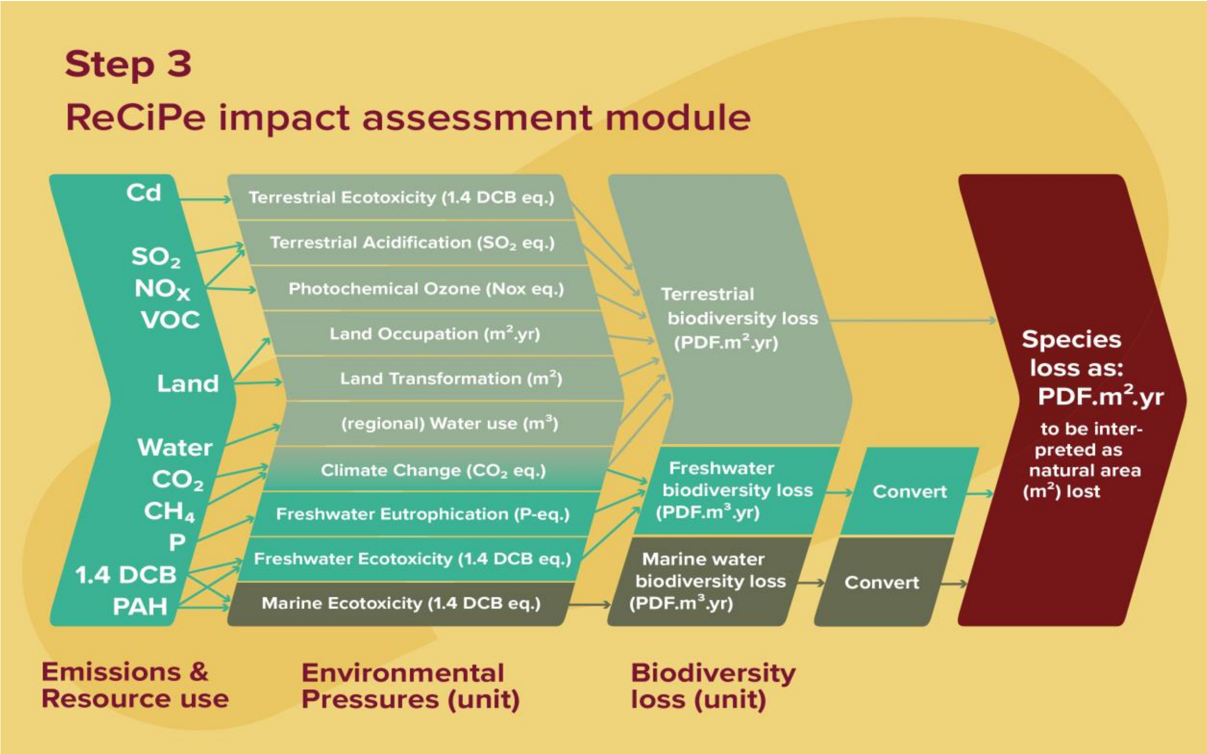


Figure 5: Schematic overview of the environmental mechanisms in the ReCiPe method and their relation to the endpoint. Adapted from: 'ReCiPe 2016. A harmonized life cycle impact assessment method at midpoint and endpoint level', RIVM[4].

The result of this calculation in step 3 is a number with the unit called "species.year"[5] The unit "species.year" is the official unit of ReCiPe, but for our purpose it is not very meaningful. We will convert all impacts on water back to the unit for land-based system, so the unit is thus PDF.m^2.yr. If we get a result of 100 PDF.m^2.year, this means we may have a complete loss (PDF=100%) of biodiversity on an area of 100 m^2 during a year, or a loss of 10% of the species on an area of 10m^2 over a period of 100 years. PDF, area size, and time are interchangeable. To make the presentation of the result even simpler, we will set the time to one year, because the scope of the footprint in annual. We set the PDF to 100% (all biodiversity is lost). This allows us to express the result simply as m^2 lost ecosystems during a year.

[4] Huijbregts, M.A.J. et al. (2016) 'ReCiPe2016: a harmonised life cycle impact assessment method at midpoint and endpoint level', Int J LCA, 22, pp. 138-147. http://www.rivm.nl/en/Topics/L/Life_Cycle_Assessment_LCA/ReCiPe.

[5] The following data are used for species density on land per m2: 1.48E-8; Species density in Fresh water, per m^3: 7.89E-10; Species density in Marine water per m^3: 3.46E-12 Note that these species density figures are quite uncertain; only a small part of all species have been documented, so it is not too well known how many species there are. This is especially true in oceans; only the upper 200 meter have been taken into account, as below this, very little is known. By using the PDF score for land, we eliminate this uncertainty for terrestrial ecosystems, while we have an extra uncertainty for aquatic systems, as these impacts undergo two conversions, one from PDF.m3.yr to species.year and one from species.year to PDF.m^2.yr. Most global biodiversity assessment tend to focus on the damage on terrestrial ecosystems, so we think it is better to have these right and include the aquatic systems with more uncertainty.

Step 4: Interpret the results and take action

As with all footprint calculations, there are limitations to the BFFI method. The footprint calculation has certain methodological and data-related limitations:

- Biodiversity impact is modelled not measured.
- Not all drivers of biodiversity loss are included in the BFFI, like overexploitation and the introduction of invasive species; the significance of these drivers needs to be assessed on a case-by-case basis (note that this was not feasible within this case study).
- For the approach that only uses publicly available data, the purchasing, resource use and emission profile are based on revenue generated per sector and country or region, not on company specific supply chain data. Sector average supply chain data of the sectors in which the company operates are used.
- The datasets on environmental inputs and outputs in the background data are industry averages and not supplier specific.
- For this project we use the open source 'EXIOBASE' database to translate economic activities into environmental pressures, like land use, water use and emissions. The base year of the database is 2011, so the data is becoming outdated. NTNU, the Norwegian University of Science and Technology, has developed a more up to date version of EXIOBASE, with more recent input-output tables and environmental extensions. Future calculations can be based on these more recent data.

These limitations mean that the results must be interpreted as an indication of where the impacts on biodiversity are likely to be located and an indication of the main causes.

3.1.2 The results

The footprint calculation provides the overall biodiversity impact in three different ways. First, the total company biodiversity footprint is provided. This is the annual biodiversity footprint expressed in ha (see step 3 in the previous paragraph for an explanation of the unit). The impact of company A, and the comparison to an average company in the AEX-index is shown in the left graph in Figure 6.

The middle graph in the same figure shows the impact per euro revenue. This measure is included to be able to compare different size companies: a smaller company is likely to have a smaller impact than a large multinational, just because of its size. By dividing the total impact by the revenue, the biodiversity impact 'intensity' is calculated.

The graph on the right side of Figure 6 shows the impact per invested euro. This metric is calculated by dividing the total impact by the market capitalization of the company. It can be used to calculate the share of impact that should be attributed to the investor. If a financial institution owns 2% of the shares in a company, that same percentage of the total footprint of the company is attributed to the owner of the shares. This measure should be interpreted with care since share prices can fluctuate. An alternative to the market cap is the enterprise value. When the enterprise value is used, the impact is not only attributed to the equity side of the company, but also to those who provide loans to a company.

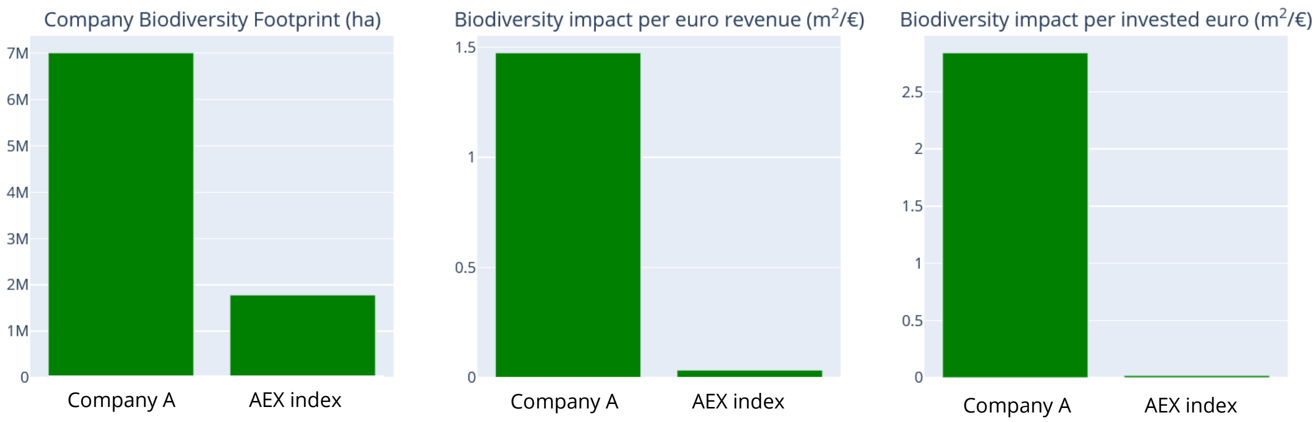


Figure 6: Biodiversity impact of Company A compared to the AEX index as a benchmark.

In this example, we see that the steel making company has a relatively large annual impact on biodiversity (7 million ha where all biodiversity is lost during one year) compared to the average of the 25 biggest companies listed on the Amsterdam Stock Exchange (1.8 million ha where all biodiversity is lost during one year). The sectors in which this steel company generates its revenue are relatively harmful for biodiversity (almost 1.5 m^2 per euro revenue), compared to 0.033 m^2 per euro revenue for the average company in the AEX. The market cap is relatively low compared to the revenue, so the impact per invested euro is also very high (2.8 m^2/€) compared to the impact per invested euro in the average AEX company (0.017 m^2/€).

The contribution analysis: drivers of biodiversity loss and production processes
The second part of the BFFI results consists of the contribution analysis. In the contribution analysis, the main drivers and the main contributing processes are distinguished.

The following chart shows the impact of the different drivers of biodiversity loss. In this figure, we can see that 60% of the biodiversity impact is caused by greenhouse gas emissions. These emissions lead to climate change which in turn leads to biodiversity loss. Other important drivers are acidification due to airborne emission of Sulphur dioxide (83 % of all acidification impact), Nitrogen oxides (16 % of all acidification impact), and Ammonia (2 % of all acidification impact). Water consumption is the third biggest driver of biodiversity loss. Land use by Company A and its supply chain is causing 8% of all biodiversity loss. Ozone formation (5% of the impact) is caused by emissions of Nitrogen oxides and non-methane volatile organic compounds.

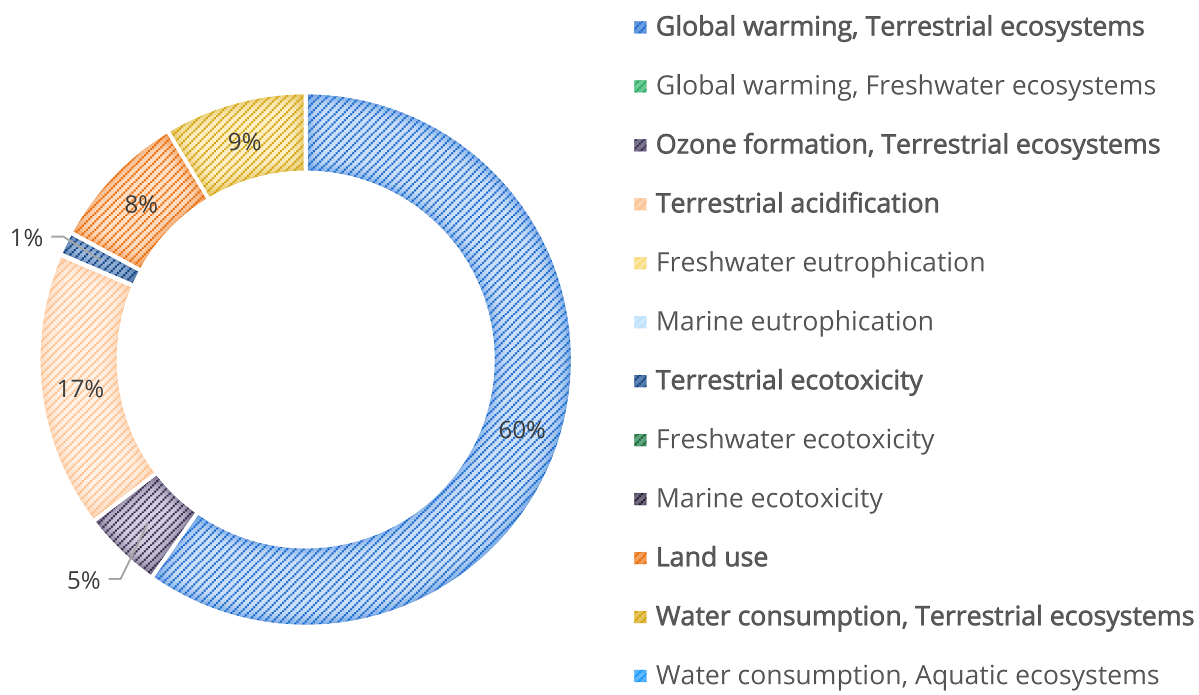


Figure 7: Contribution per driver of biodiversity loss
(Drivers contributing more than 1% of the total impact are shown in bold)

The table below shows another contribution analysis of the total annual biodiversity footprint of Company A. In this table the impacts are split by sector. Most of the impact is caused by the manufacturing of basic iron and steel and of ferro-alloys and first products thereof. All other sectors that contribute to more than 0,5% of the total impact are included separately, while the sectors contributing to less than 0,5% of the impact are grouped in the category “remaining sectors.”

Table 2: Contribution to the total biodiversity loss of Company A and its supply chain split by sector.

Sector	Biodiversity impact (Ha)	Share of total impact
Manufacture of basic iron and steel and of ferro-alloys and first products thereof	5718889	82,0 %
Manufacture of coke oven products	213098	3,1 %
Chemicals nec	145423	2,1 %
Petroleum Refinery	133004	1,9 %
Manufacture of fabricated metal products, except machinery and equipment	68697	1,0 %
Transport via railways	60684	0,9 %
Inland water transport	42908	0,6 %
Casting of metals	40175	0,6 %
Mining of iron ores	33645	0,5 %
Remaining sectors	521948	7,5 %

3.2 Dependencies on ecosystem services for a multinational steel manufacturer.

3.2.1 The approach

A four-step approach is suggested to determine direct dependencies on ecosystem services (Figure 8).

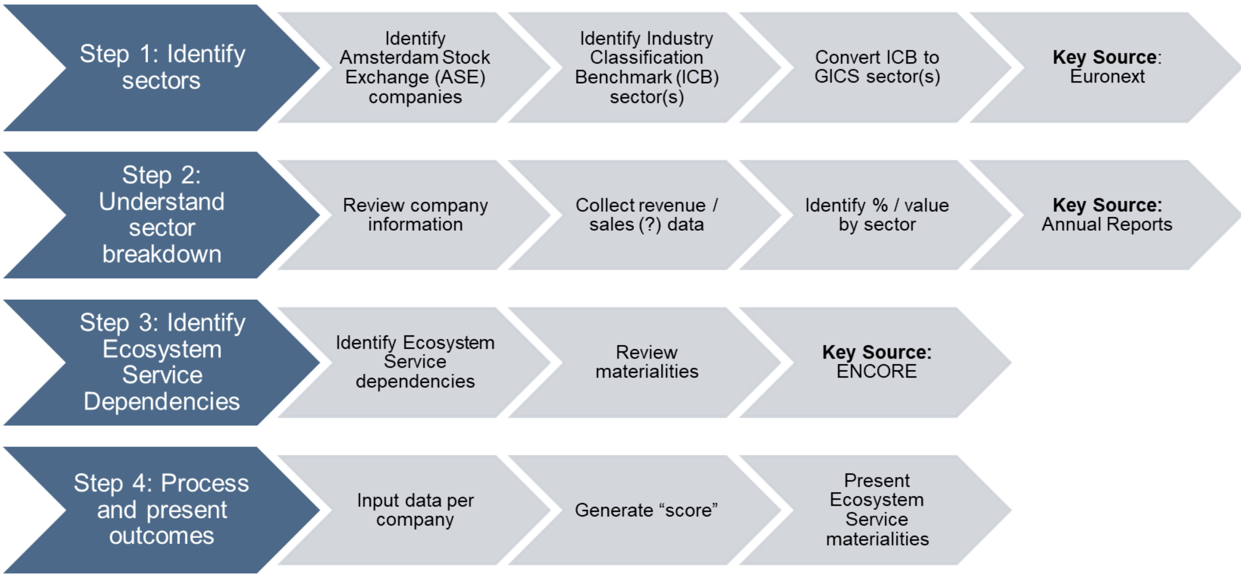


Figure 8: Four-step approach to determining direct dependencies on ecosystem services

Sectors in this case refers to sectors, sub-industries and/or production processes at company level, but could potentially be applied to portfolio level aggregation/display. This approach focuses on **direct dependencies only**. Further consideration and development would be required to determine how indirect dependencies could be integrated and displayed.

Step 1 – identifying relevant sectors: This step will use the information provided in the 'Characteristics' and 'Company Information' on the Euronext website to identify companies on the Amsterdam Stock Exchange (ASE). The Industry Classification Benchmark (ICB) sectoral classifications, and any information on sub-sectors or processes, provided on the Euronext website will then be converted to GICS sectors so they can be mapped to ENCORE (e.g. Figure 9). The preferred option for this step is to use an agreed crosswalk table (also called concordance table) between ICB and GICS classifications. Crosswalk tables are being developed by the EU Technical Export Group on Sustainable Finance and will be made publicly available in the future. However, if a crosswalk table is not available the conversion can be completed manually.

Company A	ICB (Euronext)
Sector	Industrial Metals and Mining
Subsector	Iron and Steel

Company A	GICS (ENCORE)		
GICS Sector	Materials		Energy
GICS Sub-industry	Steel	Iron	Coal & Consumable Fuels
ENCORE Production process	Steel production	Iron extraction	Mining

Figure 9: Example sector translation from ICB to GICS

Where information on company sub-sectors or production processes is not available, the company's website and most recently/available Annual Report will be reviewed for relevant information (e.g. Segment Reporting). The outcome of this step will be a list of ASE companies with a breakdown of sectors, sub-industries, and production processes, aligned with GICS and ENCORE.

Step 2 (if required) – understanding sector breakdown: This step involves further research to gather more information on the company (or portfolio), such as percentage or value of investment in the sectors, sub-industries and/or production processes identified in Step 1. A range of sources will be used, starting with publicly available annual/financial reports and company websites. Where this information is not available, other proprietary or subscription sources of financial information may need to be explored.

Information collected could include revenue, sales, loans and/or investments. A decision will need to be made on which of these figures are used in the analysis to maintain consistency i.e. whether commonly published information such as revenue is used as a proxy instead of more accurate investment figures that may not be widely available. Initial calculations may need to be conducted to determine the breakdown by sector and any associated assumptions documented. For example, if only total revenue and the percent contribution of sectors to the business are provided, a sector breakdown could be assumed from this (Table 3).

Table 3: Illustrative example of sector breakdown calculation

Company	Total Revenue (USD)	Sector	Sector Contribution	Assumed Revenue by Sector (USD) *Total revenue x sector contribution*
Company A	100,000	Materials	75%	75,000
		Energy	25%	25,000

The outcome of this step will be a breakdown of investment/revenue associated with the sectors, sub-industries and production processes for each company identified in Step 1. Step 2 may not be required if the intended approach only seeks to identify ecosystem service direct dependencies at a high level, rather than indicate e.g. percent or value of a company or investment portfolio that has those direct dependencies.

Step 3 – identifying ecosystem service direct dependencies: In this step, the sector information collated in Step 1 is used to identify the associated ecosystem service dependencies in ENCORE. The materiality (very low to very high) of those dependencies is also collated. The outcome of this step will be the ecosystem service dependencies and materiality for each production process (where possible) that an individual company undertakes (e.g. Table 4).

Table 4: Illustrative example of sector direct dependencies and materiality for the production process

	Sector	Sub-industry	Production Process	Direct Ecosystem Service Dependencies	Materiality
Company A	Energy	Coal & Consumable Fuels	Mining	Mass stabilisation and erosion control	Medium
	Energy	Coal & Consumable Fuels	Mining	Surface water	High
	Energy	Coal & Consumable Fuels	Mining	Water flow maintenance	High
	Energy	Coal & Consumable Fuels	Mining	Ground water	High
	Energy	Coal & Consumable Fuels	Mining	Climate regulation	High
	Materials	Steel	Steel production	Ground water	Medium
	Materials	Steel	Steel production	Surface water	Medium
	Materials	Steel	Steel production	Water flow maintenance	Medium
	Materials	Steel	Steel production	Climate regulation	Very Low
	Materials	Steel	Steel production	Mass stabilisation and erosion control	Low
	Materials	Iron	Iron extraction	Mass stabilisation and erosion control	Medium
	Materials	Iron	Iron extraction	Ground water	High
	Materials	Iron	Iron extraction	Surface water	High
	Materials	Iron	Iron extraction	Water flow maintenance	Medium
	Materials	Iron	Iron extraction	Climate regulation	Medium

Step 4 – processing and presenting outcomes: The final step is to collate all the information gathered in Steps 1 to 3, process it, and present a summary of the company's direct dependencies on ecosystem services. This could be done in several ways, as outlined below.

3.2.2 The results

Overview

This section provides illustrative examples for how the outcomes from Steps 1-3 could be presented. The intention is for these to be integrated in the outputs of the BFFI, for example in the form of a two- or three-page summary document or as part of an Excel document, providing impacts and dependencies information to users of the BFFI. In future applications of the methodology, the results should be tailored to the specific needs of the financial institution.

Three company level options are presented as well as a portfolio level option. The latter is not based on the same profile of the multinational steel manufacturer, but rather on an entirely fictional set of companies and dependencies. The portfolio display option serves as an initial view of what can be provided at this stage to financial institutions at the portfolio level. It is proposed that financial institutions may wish to use both the company level outputs as well as the portfolio level outputs.

The benefits and limitations of the display options outlined in this section are summarised in Table 5. Further details are provided in Annex A on the calculations underpinning the display options.

Table 5: Summary of benefits and limitations of display options

Display option	Benefits	Limitations
Company level		
Option A	• straightforward process • limited input information required • simple output	• low granularity • more production processes = more direct dependencies, irrespective of operation size
Option B.1	• some granularity on type of direct ecosystem service dependencies • gives a weighting based on materiality • considers the contribution of each production process overall sales	• additional process • not directly comparable between companies • sales figures per production process may not be available
Option B.2	• some granularity on type of direct ecosystem service dependencies • considers the contribution of each production process to overall sales • potential to 'compare' the 'value' of two companies' direct dependencies	• more complex process • sales figures per production process may not be available • explanation of approach and uses of the outcome required
Portfolio level		
Portfolio level	• some granularity on type of direct ecosystem service dependencies • gives a weighting based on materiality • potential to look at direct dependencies on ecosystem services across a portfolio • potential to 'compare' the 'value' of two companies' direct dependencies	• more complex process • increased potential for input data limitations (e.g. sales figures per production processes) • detailed explanation of approach and uses of the outcome required

Company level display option A

Helps answer	• What ecosystem service direct dependencies does this company have? • How material are they?
Display based on	• The number of times an ecosystem service direct dependency is linked to a company's production process(es) (or sector / sub-industry) (Figure 10); and/or • The number of direct dependencies at each materiality level (very low (VL) to very high (VH)) (Figure 11).

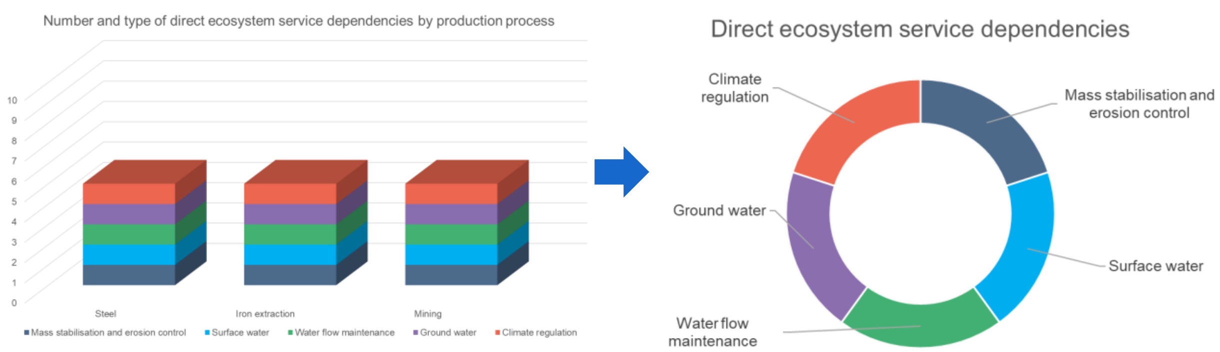


Figure 10: Direct ecosystem service dependencies by sector

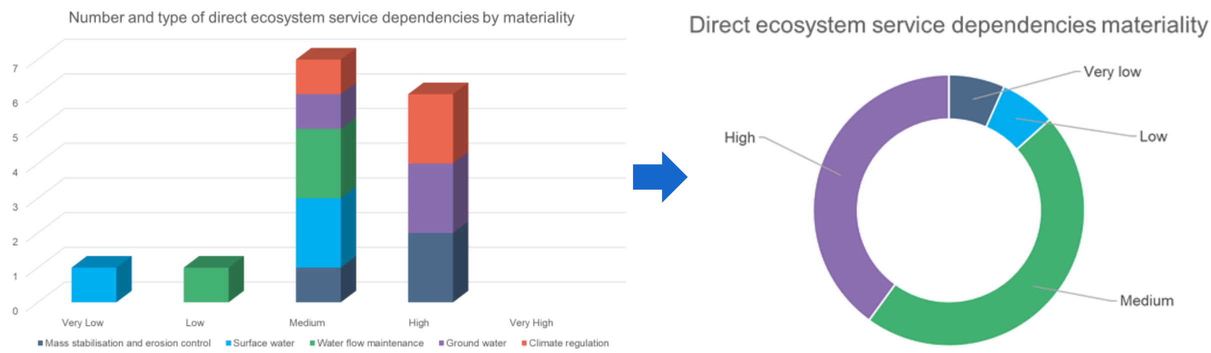


Figure 11: Materiality of direct dependencies

These outputs show that:

- this company's production processes have direct dependencies on five ecosystem services;
- each of the three production processes this company is involved with (steel production, iron extraction and mining) have direct dependencies on the **same** five ecosystem services; and
- the materiality of the direct dependencies of each production process on the ecosystem services vary, but most are medium or high, and none are very high.

The advantage of this approach is that it is straightforward, with limited input information required. However, the outputs do not provide much granularity and companies with more production processes are likely to come out with more direct dependencies, irrespective of the contribution that each process makes to the company's overall operations.

Company level display option B.1

Helps answer	• What direct ecosystem service dependencies does this company have, taking into account materiality (and sales)?
Display based on	• Weighted materiality (VL = 1 to VH = 5)[6] by ecosystem service (Figure 12); and • Weighted or unweighted percent process (or sub-industry) contribution to sales (Figure 13).

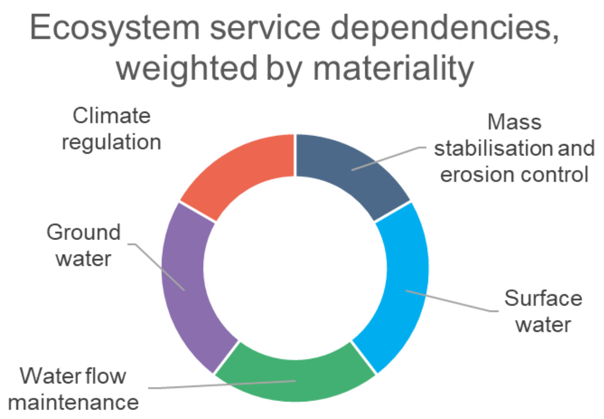


Figure 12: Weighted direct dependencies by ecosystem service

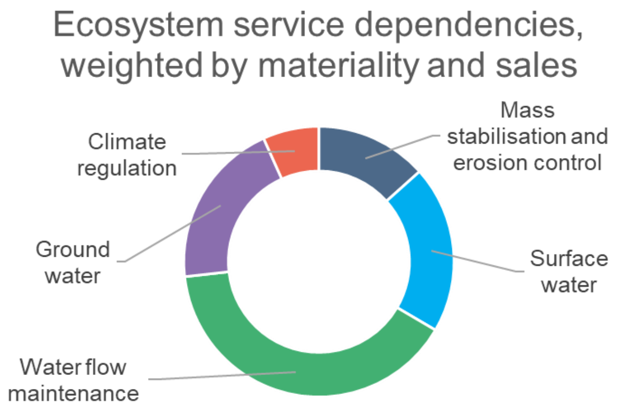


Figure 13: Weighted direct dependencies by ecosystem service adjusted for percent sales

[6] Scores for the weights assigned to Very Low (VL = 1) through to Very High (VH = 5) were chosen for simplicity, and because other weighting systems (e.g. 1 to 10, or 0-1) have not been found to substantially alter results.

This output shows that:

- this company's production processes have direct dependencies on five ecosystem services;
- accounting for how 'material' they are, this company's 'greatest' direct dependencies are on surface water and ground water;
- when the contribution of each production process to the company's overall sales are taken into account, this changes, and water flow maintenance becomes the 'greatest' direct dependency.

The advantages of this approach are that it provides some granularity on the type of direct ecosystem service dependencies a company has, taking into account how material those dependencies are. It also considers the percent contribution of each process to the company's overall sales. However, it is a more complex process and isn't directly comparable between companies, because it looks at the percentage contribution of a process rather than the absolute value. Furthermore, it may not be possible to get sales figures per production process for all companies of interest from public sources.

Company level display option B.2

Helps answer	• What are the indicative financial values potentially associated with this company's direct ecosystem service dependencies?
Display based on	• Weighted materiality (VL = 1 to VH = 5) by direct ecosystem service; and • The financial value that a process (or sub-industry) contributes to sales.

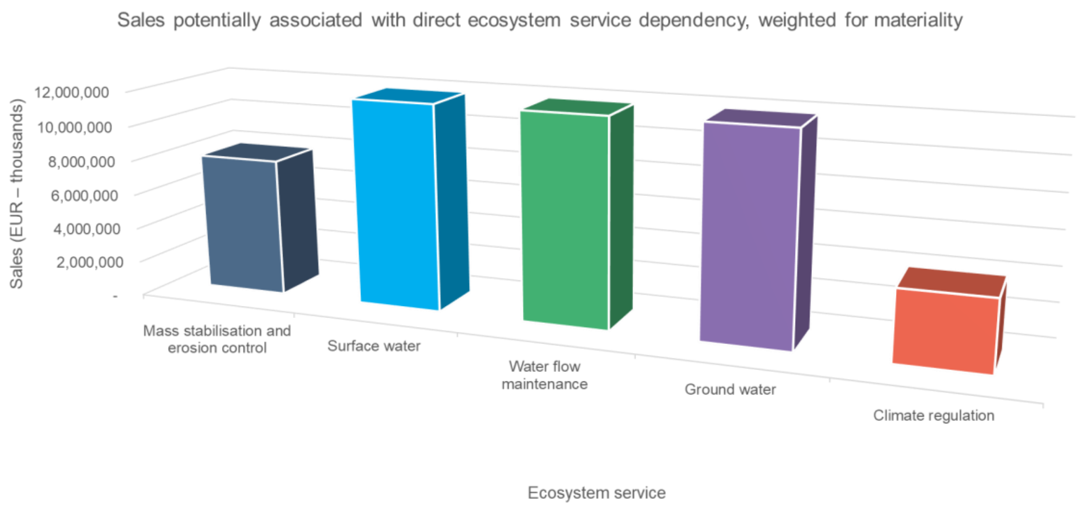


Figure 14: Sales potentially associated with direct dependency, weighted for materiality

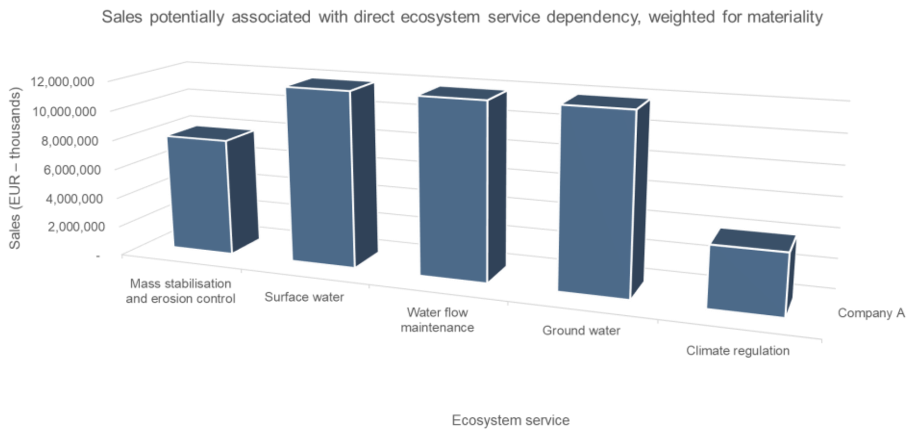
This output shows that:

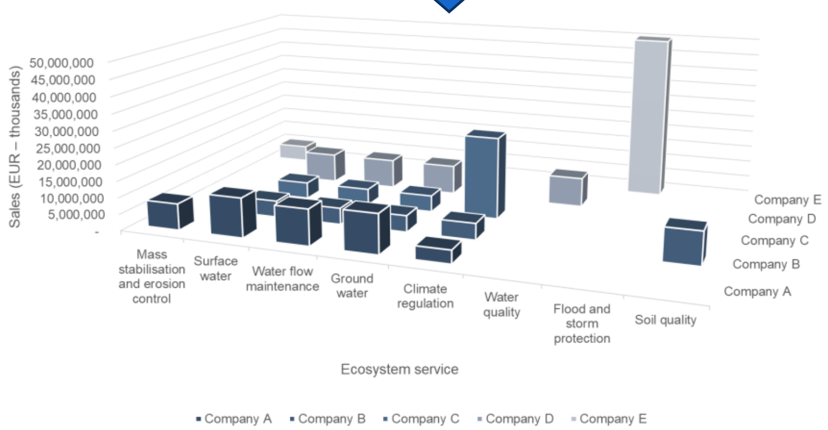
- this company's production processes have direct dependencies on five ecosystem services;
- accounting for how 'material' they are, this company's 'greatest' direct dependencies are on water-related ecosystem services;
- approximately ¾ of the company's sales, or approximately 35,000,000 (EUR – thousands), are associated with production processes that have some level of direct dependency on water-related ecosystem services (surface water, water flow maintenance and ground water).

The main advantage of this approach is that it may be possible to 'compare' the 'value' of two companies' direct dependencies on particular ecosystem services. As with option B.1, it provides some granularity on the type of direct ecosystem service dependencies a company has, taking into account how material those dependencies are. It also considers the value of each process to the company's overall sales. However, it is more complex, and it may not be possible to get sales figures per process for all companies of interest from public sources. An explanation of how the display option is generated will be required to help with appropriate use of the information.

Portfolio level display option

Helps answer	• What are the indicative financial values potentially associated with a portfolio's direct ecosystem service dependencies?
Display based on	• Option B.2 above but adapted to include multiple companies; this therefore provides an indication of direct ecosystem service dependencies across the portfolio.





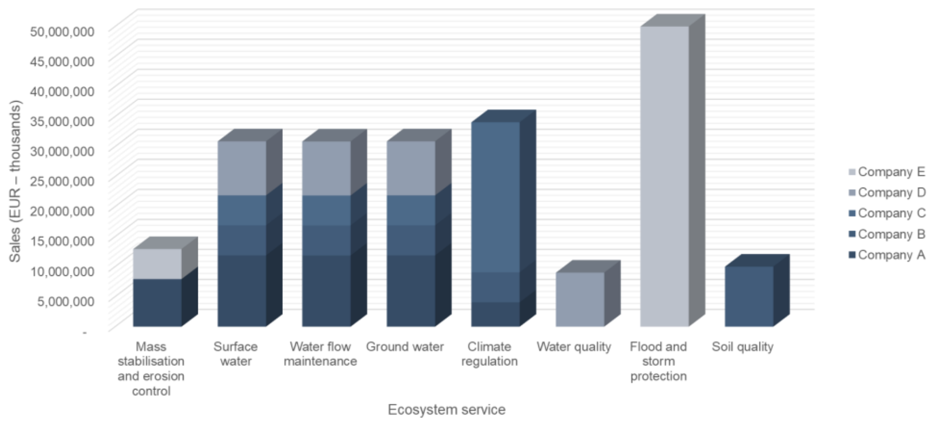


Figure 15: Example of sales potentially associated with direct dependency, weighted for materiality, across an illustrative portfolio[7]

Alternatively, or in addition to the visual display, this output could be presented in tabular format (e.g. Table 6) to allow sorting and analysis.

Table 6: Illustrative example of value of sales potentially associated with dependency, weighted by materiality (EUR - thousands)[7]

PORTFOLIO: XXXXX	DATE:	00/00/000					
Direct Ecosystem Service Dependency	Company A	Company B	Company C	Company D	Company E	Total	% of Portfolio
Water quality				9,000,000		9,000,000	4%
Soil quality		10,000,000				10,000,000	5%
Mass stabilisation and erosion control	8,000,000				5,000,000	13,000,000	6%
Water flow maintenance	11,000,000	5,000,000	5,000,000	9,000,000		30,000,000	14%
Surface water	12,000,000	5,000,000	5,000,000	9,000,000		31,000,000	15%
Ground water	12,000,000	5,000,000	5,000,000	9,000,000		31,000,000	15%
Climate regulation	4,000,000	5,000,000	25,000,000			34,000,000	16%
Flood and storm protection					50,000,000	50,000,000	24%
Total	47,000,000	30,000,000	40,000,000	36,000,000	55,000,000	208,000,000	

These illustrative outputs show that:

- companies in this portfolio have direct dependencies on a range of ecosystem services;
- four of the five companies in this portfolio have direct dependencies on water flow maintenance, surface water and ground water; and
- accounting for how 'material' they are, and the proportion of sales associated with them, this portfolio's 'largest' direct dependencies are on flood and storm protection (potentially associated with around 24% of the total sales in the portfolio), due to one company in the portfolio (Company E) having a very high dependency on this ecosystem service.

The main advantage of this approach is that it may be possible to look at direct dependencies on particular ecosystem services across a portfolio. It provides some granularity on the type of direct ecosystem service dependencies a portfolio has, taking into account how material those

[7] These figures are not based on real companies and are for illustrative purposes only.

dependencies are. It also considers the value of each process to the portfolio's overall sales. However, it is more complex, and it may not be possible to collate sales figures per process for all companies within a portfolio. Across a large portfolio, a lack of input data may reduce the accuracy of the display. Furthermore, detailed explanation of how the display option is generated will be required to help with appropriate use of the information.

3.3 Feedback from stakeholders & recommendations for further improvement

Geographical context

The approach outlined above provides a good initial estimate of potential dependencies for companies and financial institutions. However, it does not consider spatial information, for example on the state of ecosystem services or their underlying natural capital assets. Such spatial information is not currently widely available, as such it could not be integrated at this stage. Once this kind of data is available it would be beneficial to integrate it in future iterations of the approach. An example of suitable data would be the spatial data layers aimed at identifying hotspots of natural capital risk outlined in section 2.5 above, which are being developed by UNEP-WCMC. In time it may also be possible to assess the resilience of ecosystem services to different pressures.

Indirect dependencies

The approach outlined above currently only displays direct dependencies on ecosystem services. It is important to note that indirect dependencies should be considered as well. However, this will require further thought, particularly for the options that integrate financial data. This is because most of the financial value is generated towards the consumer end of supply chains, whereas more upstream economic activities are often those with the highest dependencies on ecosystem services. As such weighting by financial data like revenue may produce a false picture of dependencies.

Cumulative portfolio dependencies

In the longer term it may be beneficial to consider including an assessment of cumulative portfolio dependencies. This would require similar spatially explicit data on the geographical context and an indication of where each company in a portfolio is sourcing from. This would allow identification of hotspots of sourcing and the status of ecosystem services in those areas. Example outputs could be statements such as “X% of your portfolio is likely sourcing from the same high-risk area” or “X% of your portfolio is likely sourcing from Y locations identified as having high disruption risk”.

Scale for materiality ratings

In the approach described above the score associated with each materiality rating increase in a linear fashion from Very Low =1 to Very High = 5. The scale could be adjusted to be for example, Very Low = 1 and Very High = 10. This could allow to cater for different risk appetites of users of the BFFI.

4 Testing the BFFI impact/dependency score and profile

We further tested the method by calculating impact scores and dependency profiles for all companies in the AEX index. The results can be presented in a dashboard which allows the user to select one of the 25 companies to display the annual biodiversity footprint (and compare to the AEX average), and the companies dependencies on ecosystem services.

4.1 Results

Below, the results of the biodiversity impact calculations are shown for the AEX as a whole. For an overview of how the results for the dependency analysis could be displayed, see the 'portfolio display options' in the previous chapter.

The following chart shows the total annual biodiversity loss per company in PDF.ha.yr. The unit is simplified to ha, where all biodiversity is lost (PDF = 1), during one year (yr = 1). The different colours indicate the relative contribution per driver of biodiversity loss. Climate change, land use, acidification, water use, and ozone formation are the most important drivers for this group of companies.

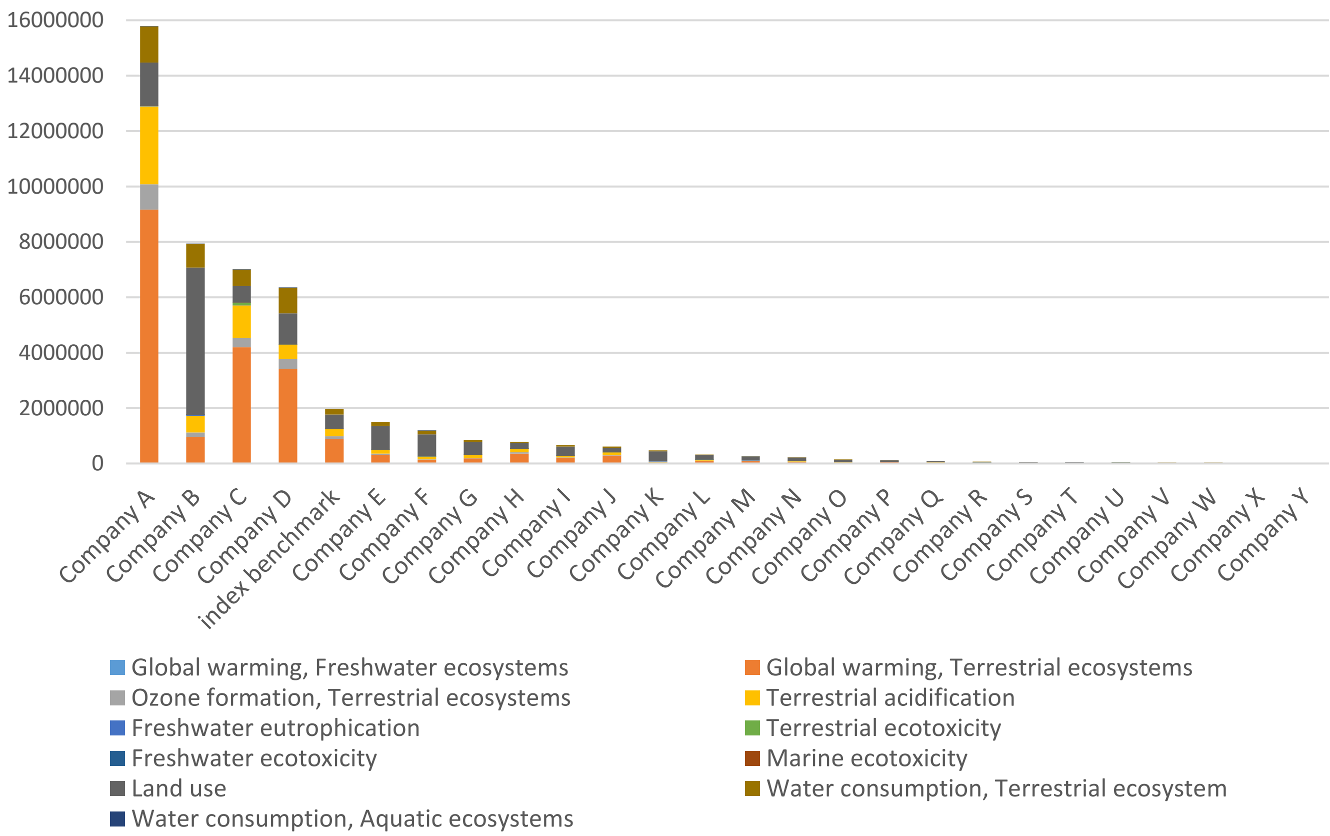


Figure 16: Annual biodiversity footprint of the AEX constituents in ha (derived from PDF.ha.yr) split by driver of biodiversity loss.

It is to be expected that companies with large revenues also have bigger footprints. Therefore, the impact per euro revenue is a relevant metric to display. This allows a comparison of the biodiversity intensity of the revenue per company. The biodiversity footprint intensity per euro revenue is show below in Figure 17.

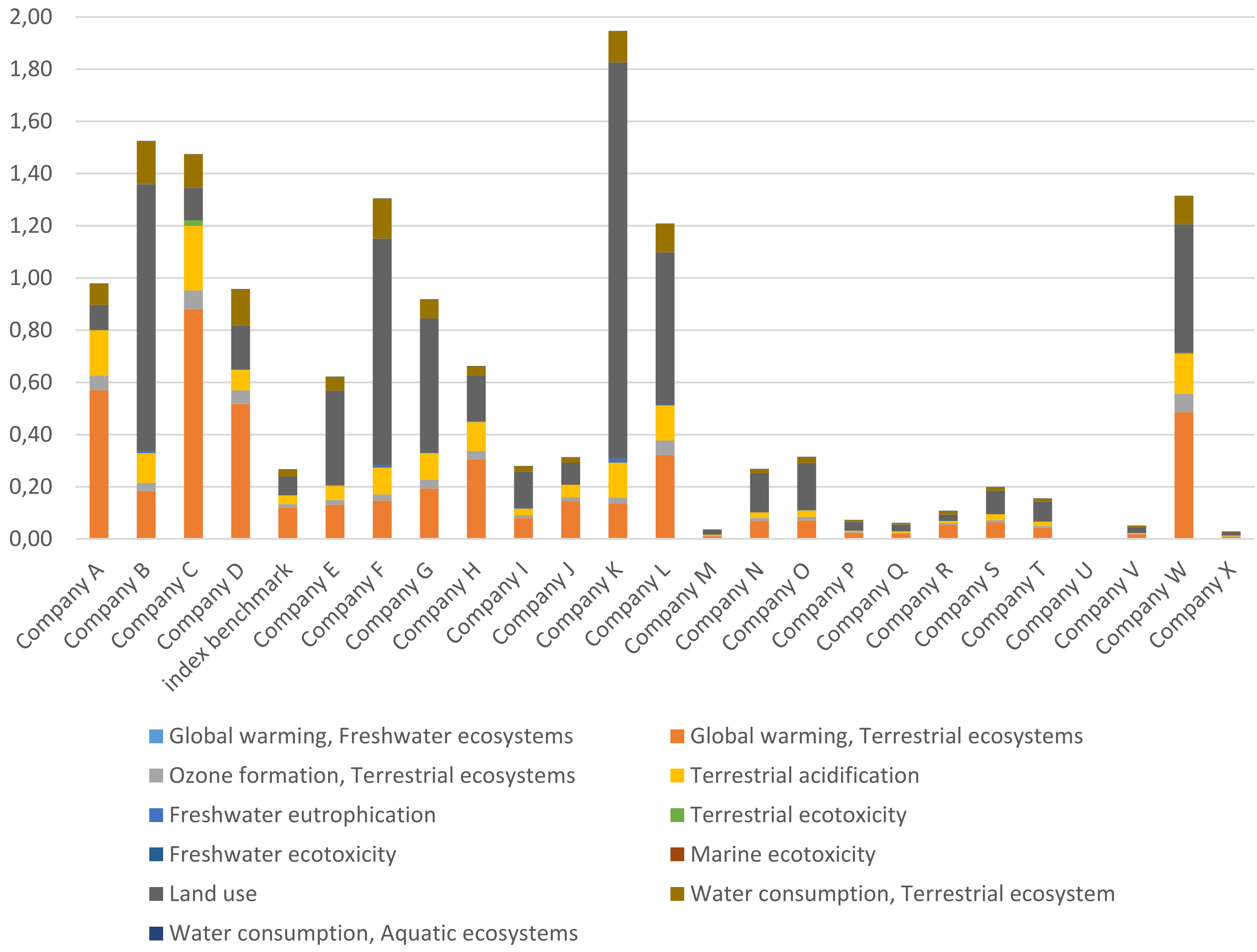


Figure 17: Annual biodiversity footprint intensity of the AEX constituents in m2 per euro revenue (derived from PDF.ha.yr) split by driver of biodiversity loss.

In this figure, we can see that company K has a large footprint relative to its revenue, and that the main driver of biodiversity loss for this company is land use change. The impact of company K would not stand out if we would only look at the total footprint (in Figure 16), because companies with much bigger revenues have larger biodiversity footprints. Therefore, this way of presenting the results allows for a better comparison of different companies.

Interpretation guidance for dependencies information is provided in section 3.2 above.

4.2 Use case for FIs

Uses of the biodiversity impact profile (footprint) and dependency profile are the following:

- *Insight in the biodiversity impact hotspots and the relevant ecosystem services in a portfolio enables a focus where it matters*
  The footprint and dependency profile show where biodiversity impact hotspots and material dependencies are in an investment portfolio. It enables financial institutions to focus and prioritise efforts to minimise negative impacts, optimise avoided and positive impacts and it serves as a starting point for taking dependencies into account. Financial institutions can then 'zoom in' on specific investments and gathering more specific data where needed.

- *The footprint and dependency profile inform engagement with investees*
  The biodiversity footprint shows where the highest impacts on biodiversity are (in what sectors and what activities?) and what drivers are behind the impact. This information is key to focus engagement on the right sectors and ask the right questions (are the drivers of biodiversity loss adequately managed by the company?). Furthermore, information on material dependencies on ecosystem services allows engagement and mitigation of risks caused by these dependencies in cases where the continuation of the service in under threat. Note that the latter will require information on the location of the production processes and the provision of ecosystem services, which will require additional (ecological) research.

- *The footprint results and the dependency profile can be used for a biodiversity and ecosystem services policy, investment criteria and investment decisions*
  Insights from the footprint on the main drivers of biodiversity loss and main dependencies on ecosystem services in specific sectors can be used as an input to a biodiversity and ecosystem services policy. This information van help to develop or adjust investment criteria and to inform investment decisions. Please note that a biodiversity policy and investment criteria can also be used to address topics which cannot yet be included in a biodiversity footprint. For example, the impact of invasive species cannot yet be quantified in a footprint, but 'managing the introduction of invasive species' can be part of investment criteria (e.g. in sectors where the introduction of invasive species plays an important role). By including these topics in investment criteria, their potential role in the footprint will reduce, improving the accuracy of the footprint. Information on the main material dependencies in a specific sector can be used to develop investment criteria addressing these dependencies. For example, in case of dependencies on surface water, a water management plan could become a precondition for investment.

- *The footprint results and the dependency profile can trigger discussion on biodiversity and ecosystem services.*
  A footprint calculation triggers discussion between the investor and the investee. Not just on the topics included in the footprint calculation, but also on the topics not included in the footprint calculation. It provides investors and investees with a valuable starting point to identify ways to gather the data needed to improve the footprint calculation and to discuss steps to reduce negative impacts and generate positive impacts. This can also be the case for the dependencies. If certain ecosystems services show up in the dependency profile, the company can evaluate if these dependencies are known, if they are indeed material in their specific (geographic) context, and if they are already covered in the sustainability policy, or that further action is needed to mitigate the risk of the dependency.

5 Conclusion & Recommendations

In this project we explored the data needs, the methodology and the presentation of the results when biodiversity impact and dependency profiles are assessed simultaneously. Building on the existing work of the BFFI, the ENCORE knowledge base and the application of ENCORE data by DNB and PBL, we developed a method and different ways to display the results. The projects leads to the following conclusions and recommendations (mainly focusing on the integration of dependencies)

5.1 Conclusions

Integration of dependencies in the BFFI is feasible
The project has shown that the integration of dependencies in the BFFI, using the dependency data from the ENCORE knowledge base is possible, building on the analysis of sectors linked to an investment (already included as a first step in an impact assessment). This results in an overview of the number of ecosystem services a company depends on, the type of ecosystem services involved and their materiality and a weighted materiality based on the contribution of these ecosystem services to the sales of a company. See the example for a (fictive) portfolio in the table below.

The fact that the integration of dependency data in the BFFI is possible means that an integration of dependency data in similar LCA-based impact assessment methodologies is likely to be feasible as well.

PORTFOLIO: XXXXX	DATE:	00/00/000					
Direct Ecosystem Service Dependency	Company A	Company B	Company C	Company D	Company E	Total	% of Portfolio
Water quality				9,000,000		9,000,000	4%
Soil quality		10,000,000				10,000,000	5%
Mass stabilisation and erosion control	8,000,000				5,000,000	13,000,000	6%
Water flow maintenance	11,000,000	5,000,000	5,000,000	9,000,000		30,000,000	14%
Surface water	12,000,000	5,000,000	5,000,000	9,000,000		31,000,000	15%
Ground water	12,000,000	5,000,000	5,000,000	9,000,000		31,000,000	15%
Climate regulation	4,000,000	5,000,000	25,000,000			34,000,000	16%
Flood and storm protection					50,000,000	50,000,000	24%
Total	47,000,000	30,000,000	40,000,000	36,000,000	55,000,000	**208,000,000**	

Use of the results of an assessment of direct dependencies
The test for the companies in the AEX index shows that the assessment provides valuable information on the potential impacts on biodiversity and the direct dependency risks for the companies involved. The insight in biodiversity impact and the drivers of biodiversity loss underlying this impact can be used to zoom in on biodiversity hotspots, to develop or adjust a biodiversity policy and for engagement purposes. The same is true for the dependency profiles of the companies. It shows what ecosystem services a company directly depends, enabling a company specific analysis of the potential risks and ways these risks are managed. This can be used for engagement purposes.

Use of the combined result of an impact and dependency profile
An *impact profile and dependency* profile can show to what extent the impacts of a company may influence the ecosystem services it depends on. For example, a company with a high use of surface water may influence the availability of the surface water it depends on and a company with a high use of pesticides may influence the availability of pollination services (pesticides may have an impact on be populations). Such an analysis will require zooming in on the drivers of biodiversity loss (like ecotoxicity) and/or the environmental inputs and outputs (like the type of pesticides used). However, depending on the location of the company, the availability of the ecosystem services it depends on will most likely be influenced by more stakeholders (like other companies in the area and local communities). In this case, information on (trends in) the availability of ecosystem services will need to be gathered from other sources, like pollination maps or water scarcity maps.

Linking the assessment of dependencies to the state of ecosystem services
Although the analysis does provide an initial estimate of potential direct dependencies on ecosystem services, it does not yet consider spatial information on *the state of ecosystem services* and underlying natural capital assets. This means that the analysis will only tell what ecosystem services are key to focus on from a materiality and financial point of view, not if the dependencies actually translate in a financial risk.

Integration of location-specific data on the state of ecosystem services and underlying natural capital assets will only be possible if such data are available (and part of this data is already available in the ENCORE knowledge base) and the *location of the production processes* that depend on these ecosystem services is known. Data on the production locations of companies included in market indexes like the MSCI World Index are available and would allow for a more precise risk assessment of direct dependencies.

Use of financial data to provide a weighted materiality score of direct dependencies
The options to link impact and dependency data to financial data in order to provide a weighted impact or dependency score depends on the availability of financial data with a sufficient level of granularity. In practice it will not always be possible to breakdown revenue data to the different production processes underlying this revenue. This will limit the options to assess a weighted materiality based on the contribution of ecosystem services to the sales of a company.

Focusing on indirect dependencies
The analysis does not yet include *indirect dependency* risks in supply chains of companies. These indirect dependencies can be included in the same way indirect impacts are calculated in the BFFI, i.e. by modeling supply chains using databases like Exiobase. However, a limitation of modeling supply chains is the fact that it does not tell you the actual production locations and

therefore cannot be linked to data on the state of ecosystem services and underlying natural capital assets. In other words, modeling supply chains will tell you what indirect dependencies are likely to play a role, but it will not tell you if these dependencies are likely to result in financial risks (because the ecosystem services are at risk).

The availability of supply chain data is still quite limited. Companies do not or only to a limited extent report on their supply chains, which means that it is often not known what suppliers a company sources from and where these suppliers are located. This lack of data will need to be solved to enable a link between indirect dependencies and the state of ecosystem services in the supply chain.

	Direct dependencies	Indirect dependencies
Data on asset location	Available for listed companies from data providers, potentially enabling a link between direct dependencies and the state of ecosystem services	
Supply chain data		Not yet available or only to a limited extent, hindering a link between indirect dependencies and the state of ecosystem services
State of ecosystem services	Availability differs between different types of ecosystem services (e.g. data on the scarcity of water versus data on pollination)	Idem
Financial data	Data on listed companies available through data providers, allowing for a weighted materiality rating of dependencies	Availability of financial data may be limited for smaller and non-listed companies in supply chains. Weighting with financial data in the supply chain requires extra though (*)

(*) If indirect dependencies are included in the use of the BFFI, presenting the results using financial data (e.g. weighting the results based on the revenue generated by the production processes involved) will require further thought. Most of the financial value is likely to be generated towards the consumer end of supply chains, whereas more upstream economic activities are often those with the highest dependencies on ecosystem services. As such weighting by financial data like revenue may produce a false picture of dependencies.

5.2 Recommendations

How to use BFFI and ENCORE

With a biodiversity footprint, companies and financial institutions can assess the impact they have on biodiversity. Minimising the impact will reduce biodiversity loss and the risk associated with high impact operations. These risks can be reputational (negative press coverage), legal and regulatory (litigation, damages, pricing) or market related (changing consumer preferences). Different types of risks are associated with dependencies on ecosystem services. If a company is highly dependent on ecosystems services that are under threat, the risks are more physical and operational. Combining a biodiversity footprint and an ecosystem services dependencies profile shows two different sides of our relationship with nature: our impact and our dependency. If you know your impact, you can reduce it. If you know on which ecosystem services a company relies, you can investigate if the ecosystem service is under treat and if it can become a risk for your operations.

5.2.1 Recommendations BFFI

Integration of indirect dependencies

Based on the successful integration of direct dependencies in the BFFI, it is recommended to also include indirect dependencies and identify the best ways of presenting the results, taking into account the challenges with regard to the availability of supply chain data and the use of weighted scores using financial data, like revenue.

Test the findings in a dependency assessment of an actual investment portfolio

Use the project results to conduct a dependency assessment for an investment portfolio of a financial institution in order to see how the results are received within the organisation, what departments and processes benefit from the result and to what extent practices are influenced/changed.

In the longer term it may be beneficial to consider including an assessment of cumulative portfolio dependencies. This would require similar spatially explicit data on the geographical context and an indication of where each company in a portfolio is sourcing from. This would allow identification of hotspots of sourcing and the status of ecosystem services in those areas. Example outputs could be statements such as “X% of your portfolio is likely sourcing from the same high-risk area” or “X% of your portfolio is likely sourcing from Y locations identified as having high disruption risk”.

5.2.2 Recommendations ENCORE

Explore the availability and use of data on the state of ecosystem services

A dependency on ecosystem services does not necessarily translate in a financial risk. This depends on the state of the ecosystem services concerned and the trend in this state. Such spatial information on ecosystem services and underlying natural capital assets is not yet widely available, as such it could not be integrated at this stage. Once this kind of data is available it would be beneficial to integrate it in future iterations of the approach. In time it may also be possible to assess the resilience of ecosystem services to different pressures. Generating this data requires monitoring and the translation of the data monitored into a knowledge base like ENCORE. The fact that the ENCORE knowledge base currently has 360 registered users from the financial sector shows that there is a lot of interest in the data ENORE provides.

For this, action is required by governments, scientific institutes and organisations like the Ecosystem services Partnership (ESP) and UNEP-WCMC. In order to gain a better overview of the ‘state of data’, it is recommended to create an overview of the data currently available, the main data gaps and the opportunities to close those gaps. Organisations to involve include, for example, ESP, UNEP-WCMC and organisations involved in national natural capital accounts.

5.2.3 Recommendations ENCORE & BFFI

Explore the availability and use of data on production locations and supply chains
Explore the availability and opportunities of combining data on production locations (provided by data providers like MSCI and Four Twenty Seven) and supply chains with ENCORE data on natural capital assets underlying ecosystem services or other data on the state of ecosystem services already available (e.g. from national natural capital accounts), in order to assess the actual risks of ecosystem services dependencies (instead of potential risks).

Transparency and disclosure of environmental data in supply chains is key to both impact assessment and dependency assessment. However, the availability of supply chain data is still quite limited which means that supply chains need to be excluded from assessments or the assessments need to rely on modelled data. It is recommended to identify ways to make supply chain data available, e.g. by means of legislation/regulation on disclosure, including the role of the Non-Financial Reporting Directive (NFRD) and the EU Sustainable Finance Strategy, and initiatives like the TNFD and the Green Digital Finance Alliance (launched by Ant Financial Services and UN Environment Programme (UNEP)).

5.2.4 Other

Work towards a standardised approach for biodiversity/ecosystem services dependency assessments

Feed the project results into the development of guidance and dependency assessment principles by the Partnership for Biodiversity Accounting Financials (PBAF). A PBAF Standard on dependency assessments will contribute to the quality and value of dependency assessments for financial institutions.

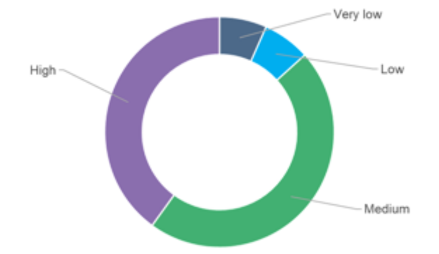
6 Annex A: Calculations behind display options

Company level display option A - workings

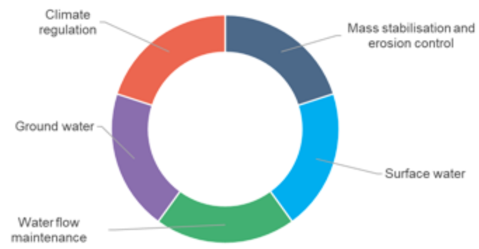
	GICS (ENCORE)		
Sector	Materials		Energy
Sub-industry	Steel	Iron	Coal & Consumable Fuels
Process	Steel production	Iron extraction	Mining

Process	Direct Ecosystem Service	Materiality
Mining	Mass stabilisation and erosion control	M
Mining	Surface water	H
Mining	Water flow maintenance	H
Mining	Ground water	H
Mining	Climate regulation	H
Steel production	Ground water	M
Steel production	Surface water	M
Steel production	Water flow maintenance	M
Steel production	Climate regulation	VL
Steel production	Mass stabilisation and erosion control	L
Iron extraction	Mass stabilisation and erosion control	M
Iron extraction	Ground water	H
Iron extraction	Surface water	H
Iron extraction	Water flow maintenance	M
Iron extraction	Climate regulation	M

Direct ecosystem service dependencies materiality



Direct ecosystem service dependencies



	Materiality					Number
Direct Ecosystem Service	**Very Low**	**Low**	**Medium**	**High**	**Very High**	
Mass stabilisation and erosion control		1	2			3
Surface water			1	2		3
Water flow maintenance			2	1		3
Ground water			1	2		3
Climate regulation	1		1	1		3
Number	1	1	7	6	0	15

Company level display option B - workings

	Materiality					Number
Direct Ecosystem Service	**Very Low**	**Low**	**Medium**	**High**	**Very High**	
Mass stabilisation and erosion control		1	2			**3**
Surface water			1	2		**3**
Water flow maintenance			2	1		**3**
Ground water			1	2		**3**
Climate regulation	1		1	1		**3**
Number	**1**	**1**	**7**	**6**	**0**	**15**

Process	**"Units"**	**"Value" (EUR '000)****	**Per "Unit"(EUR '000)**
Steel Production	12	46,807,350.86	3,900,612.57
Iron Extraction	17	380,547.57	22,385.15
Mining	19	380,547.57	20,028.82
Total	**48**	**47,568,446.00**	

** Total sales x % of sales per process (as stated in company information)

	Materiality					*Units*	*"Total" (EUR '000)*
Direct Ecosystem Service	**Very Low**	**Low**	**Medium**	**High**	**Very High**		
Weighting	**1**	**2**	**3**	**4**	**5**		
Mass stabilisation and erosion control	0	2	6	0	0	**8**	7,928,467.06
Surface water	0	0	3	8	0	**11**	11,871,493.60
Water flow maintenance	0	0	6	4	0	**10**	11,849,108.45
Ground water	0	0	3	8	0	**11**	11,871,493.60
Climate regulation	1	0	3	4	0	**8**	4,047,883.30
Total						***48***	**47,568,446.00**