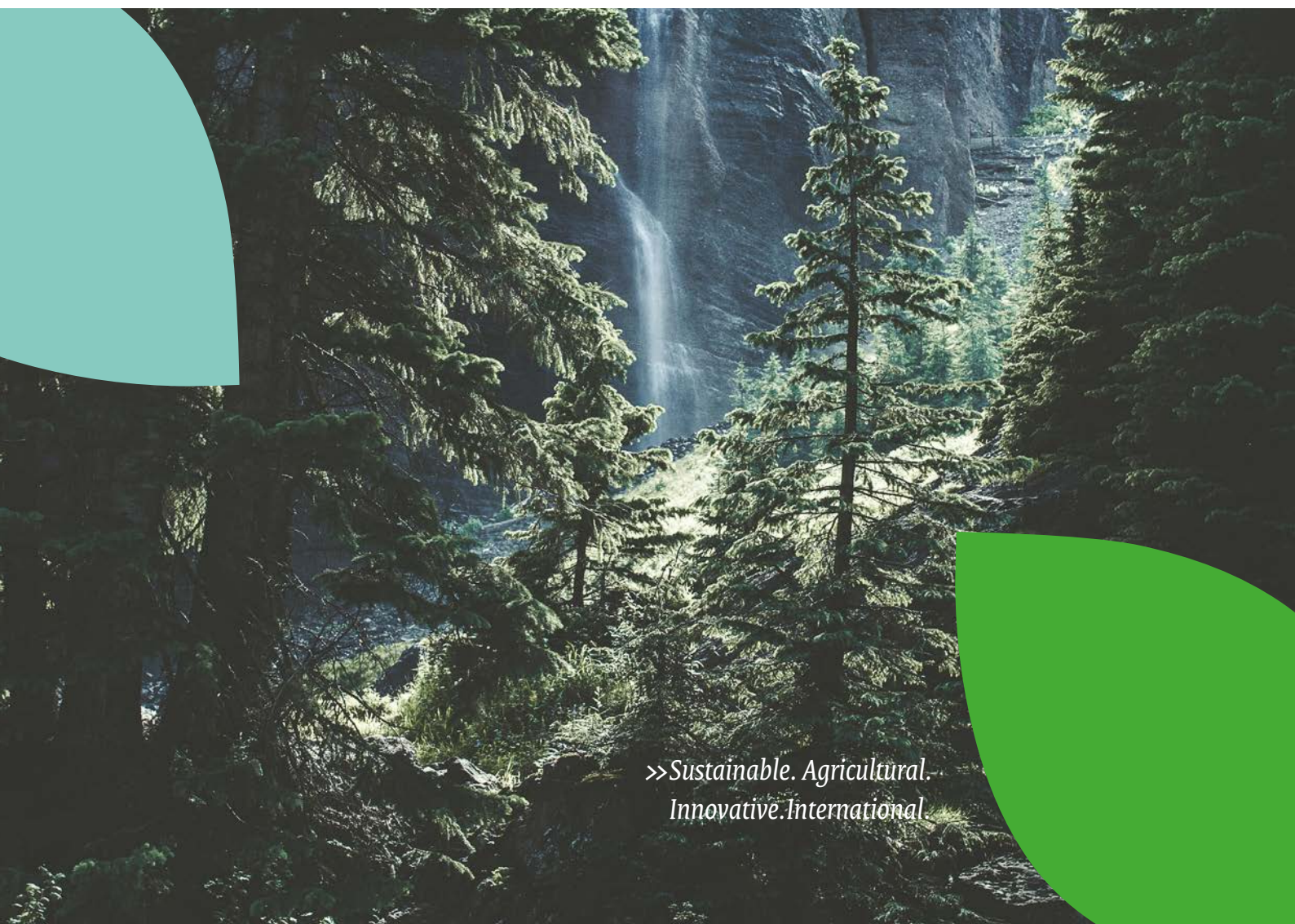




Netherlands Enterprise Agency

Biodiversity Footprint for Financial Institutions

Exploring Biodiversity Assessment



>> Sustainable. Agricultural.
Innovative. International.



Achmea Investment Management

α.σ.ι.
de nederlandse
verzekerings
maatschappij
voor alle
verzekeringen



Netherlands Enterprise Agency

Date: 16 July 2021

Version: 1.0

Commissioned by:

The Netherlands Enterprise Agency
(Rijksdienst voor ondernemend Nederland – RVO)

Prepared by:

Wijnand Broer – CREM
Daniël Kan – PRé
Ruchik Patel – PRé
Caroline van Leenders – RVO
Ko Melis – RVO

Photo by:

Thomas Kelley on Unsplash

About PRé

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 and on behalf of companies, governments, knowledge institutions, NGOs 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 RVO

The Netherlands Enterprise Agency (RVO) supports entrepreneurs, NGOs, knowledge institutes and organizations. We aim to facilitate entrepreneurship, improve collaborations, strengthen positions, and help realize national and international ambitions with funding, networking, know-how and compliance with laws and regulations. RVO runs since 2016 the Transition Program Greening Finance commissioned by the Ministry of Agriculture Nature and Food Quality.

Table of contents

1	Introduction	5
2	The BFFI approach	7
2.1	BFFI methodology	7
2.1.1	<i>Step 1: Scope and system boundary</i>	8
2.1.2	<i>Step 2: Assess environmental inputs and outputs</i>	9
2.1.3	<i>Step 3: Assess environmental pressures and the impact on biodiversity</i>	9
2.1.4	<i>Step 4: Interpret the results and take action</i>	10
3	The Cases	12
3.1	Biodiversity footprint the constituents of the MSCI World Index	12
3.1.1	<i>Scope, system boundaries and data used</i>	12
3.1.2	<i>Biodiversity Footprint results</i>	13
3.1.3	<i>Main conclusions</i>	17
3.2	Biodiversity footprint of Agrovision	17
3.2.1	<i>Scope, system boundaries and data used</i>	17
3.2.2	<i>Biodiversity Footprint results</i>	18
3.2.3	<i>Main conclusions</i>	21
3.3	Open field solar PV installation "De Rietstap"	22
3.3.1	<i>Scope, system boundaries and data used</i>	22
3.3.2	<i>Biodiversity Footprint results</i>	23
3.3.3	<i>Main conclusions</i>	26
3.4	Waternet	26
3.4.1	<i>Scope, system boundaries and data used</i>	27
3.4.2	<i>Biodiversity Footprint results</i>	28
3.4.3	<i>Main conclusions</i>	31
4	Conclusions & Recommendations	33
4.1	Conclusions	33
4.2	Recommendations	35

1 Introduction

Global biodiversity is falling at an alarming rate. This is the conclusion from the Global Assessment Report on Biodiversity and Ecosystem Services from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), from the Living Planet Report by the World Wide Fund for Nature (WWF) and it is the conclusion one can draw from a look at the IUCN Red List of Threatened Species™. In the report 'Indebted to nature' written by the Netherlands Environmental Assessment Agency (PBL) and the Dutch Central Bank (De Nederlandsche Bank, DNB), the DNB urges financial institutions to identify the risks associated with biodiversity loss and to limit their exposure to these risks¹

Financial institutions are increasingly aware of the importance of biodiversity and ecosystem services. Methods, data, and tools to quantify biodiversity impact or biodiversity loss are still in development. The participating financial institutions are looking for ways to take biodiversity impact into account in their investment decisions, and to determine the biodiversity impact of their loans and investments. The Biodiversity Footprint for Financial Institution (BFFI) can be used for this purpose. 'Biodiversity impact assessment' and 'biodiversity footprint' are used interchangeably in this report. In the past five years, ASN Bank has used and improved this method when applying it to their loans and investments.

The Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland - RVO) recognises the importance of safeguarding biodiversity and nature. Therefore, RVO commissioned this project and brought in expertise on greening the financial sector. RVO aims to get more financial institutions acquainted with biodiversity footprinting, create a flywheel effect by exchanging experiences, and involving the participants with the Partnership Biodiversity Accounting Financials (PBAF). PBAF will offer a platform to exchange knowledge and experience and set a global standard for biodiversity footprinting.

The following financial institutions used the BFFI to evaluate the biodiversity impact of loans and investments for the following case studies:

- Achmea Investment Management (Achmea IM), ASN, a.s.r asset management, APG and ING participated in the calculation of the biodiversity footprint of the constituents of the [MSCI World Index](#), which captures 1562 large and mid cap companies in developed markets.
- FMO explored the biodiversity impacts of their loan to **Agrovision**, a grower, packer, and shipper of fruits and vegetables from Peru.
- ING conducted a biodiversity footprint of their loan to the open field **solar PV installation "De Rietstap"** in the Netherlands.
- NWB Bank participated in a company footprint of **Waternet**. Waternet works for the regional waterboard Amstel, Gooi and Vecht (AGV) and for the municipality of Amsterdam for water-tasks.

The goals of these biodiversity impact assessment case studies are to:

1. Gain experience in calculating the biodiversity impact of loans and investments.
2. See if the calculations provide meaningful results to financial institutions.
3. Learn if and how these results can be used by financial institutions to:
 - a. Explore the potential biodiversity impact of loans for project finance.
 - b. Explore the potential biodiversity impact of loans to companies.
 - c. Explore the potential biodiversity impact of listed equity.
 - d. Benchmark investment portfolios.
 - e. Inform biodiversity policy and engagement.
4. Identify lessons learned and areas of improvement.
5. Facilitate the exchange of knowledge and potentially continue discussions in PBAF.

¹ DNB & PBL (2020) Indebted to nature. Exploring biodiversity risks for the Dutch financial sector.



Arthur van Mansvelt - Senior engagement specialist, Achmea Investment Management

"Achmea IM joined this project because we will need reliable data to assess the biodiversity impact of our investments. Assessing exposure and impact is a first step on the road to reduce biodiversity loss and work towards positive impact."



Roel Nozeman – Senior Advisor Biodiversity, ASN Bank and Chair of PBAF

"At ASN Bank we want to take our responsibility to protect, sustainably use and restore ecosystems. It is great to see the steps taken by the financial institutions who have joined this project. We urge others to commit to making a positive contribution to biodiversity, for instance by joining the Partnership Biodiversity Accounting Financials."



Marjolein Meulensteen – Senior portfolio manager Responsible Investing, a.s.r

"At a.s.r we are committed to take action to reverse the loss of nature this decade as much as possible. We want to collaborate and share knowledge on ESG policy, determining the impact of investments, setting targets, and reporting. This project is a great step in our journey to prevent the loss of nature and our efforts to contribute to the restoration of biodiversity."



Jos Lemmens - Senior Portfolio Manager van het Natural Resources Fund, APG

"At APG we recognize the importance of biodiversity. In this project we have gained further understanding about the drivers of biodiversity loss and where the hotspots of these losses are centered in our investment portfolio. This helps us in addressing the issue with our investee companies."



Eduardo Carilles - Manager E&S sustainability, FMO

At FMO we believe the financial industry has a role to play in halting biodiversity loss. Harmonized biodiversity impact accounting tools are essential to achieve this. Through interesting cases studies, this report demonstrates the practicality of existing methodologies such as BFFI to measure biodiversity impact, as well as the possibilities of individual investments to achieve net positive outcomes."



Booy Rodermond – Global Sustainability Advisor, ING

"At ING we recognize the importance of biodiversity and ecosystem services. As a bank, ING has an impact on biodiversity and at the same time is exposed to risks related with biodiversity loss. A better understanding of these impacts and risks is vital and that is why we are proud to have been part of this biodiversity impact assessment case study."



Merel Hendriks – Sustainability Officer, NWB Bank

"NWB Bank has a unique position in the field of finance and biodiversity. As the bank of and for the public water sector, we put the public interest and the long-term value creation at the core of our strategy. In this project we were able to expand our knowledge on biodiversity. We can now share this knowledge with our clients to help them preserve, protect and restore biodiversity."

2 The BFFI approach

Assessing biodiversity is far from a trivial thing, even when you are in a specific location and have time to study an area. The BFFI was developed by PRé, CREM and ASN Bank and is based on a life cycle assessment (LCA) approach, using an already existing pressure-impact model (ReCiPe) and environmental data from LCA databases like EXIOBASE or ecoinvent. When direct data are available, data from background databases is replaced with site- or company specific data. In the BFFI, species richness is used as an indicator for biodiversity and the damage to diversity can be described as the fraction of species that has been lost in comparison with a natural or undisturbed area.

2.1 BFFI methodology

The BFFI method is comprised of four steps (see Figure 1):

1. Understanding system boundaries: In this step, it is determined what economic activities are directly and indirectly linked to a company or project, and what scopes can be included in the analysis. For this, data on total revenue for different companies divided across sectors and geographies is collected from financial database providers and matched with specific sectors in the EXIOBASE database. The result shows to what economic activities a loan or investment is linked.
2. The identification of environmental inputs and outputs linked to the economic activities, i.e. the use of land, water, and other resources (inputs) and emissions (outputs). For this, LCA databases like EXIOBASE are used, unless more specific company or project data are available. In LCA terminology this is referred to as the 'inventory phase'.
3. The translation of emissions, land, water, and resource use into environmental pressures (like climate change resulting from greenhouse gas emissions) using the ReCiPe model, as well as an assessment of how these pressures contribute to biodiversity impact. In LCA terminology this is referred to as 'Life-Cycle Impact Assessment'.
4. Finally, the results are interpreted using both quantitative impact calculations and a qualitative analysis of the case study and the footprint results.

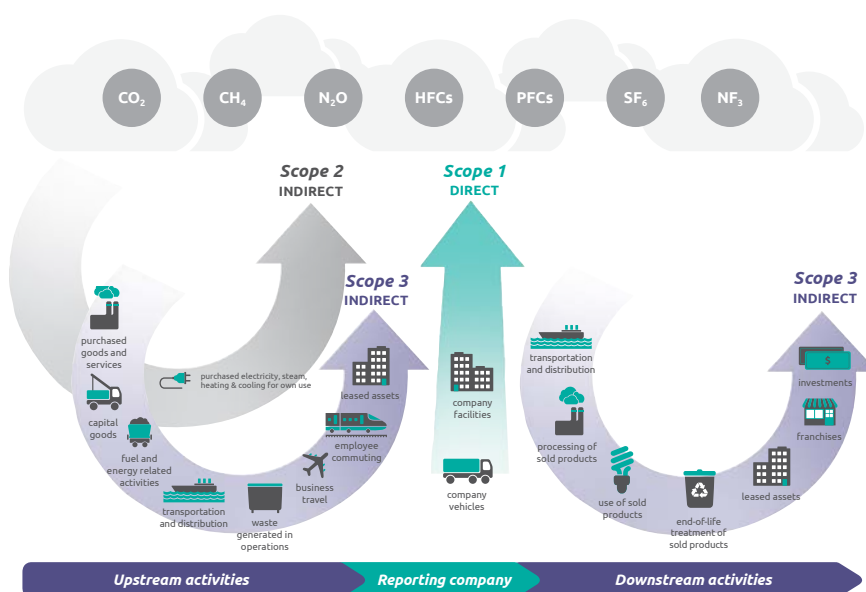
Figure 1: Overview of the BFFI Method



2.1.1 Step 1: Scope and system boundary

In the first step, an analysis is made of the activities that may have a biodiversity impact (positive or negative). An important question that needs to be answered is what scopes need to be included in the footprint. For example, if we consider a carbon footprint, the different scopes are shown in Figure 2. In a biodiversity footprint, not only carbon emissions are considered, but also other environmental pressures, such as water use, land use, emissions of nutrients and toxic substances. The full list of environmental pressures included in the analysis can be found in ‘Step 3: Assess environmental pressures and the impact on biodiversity’.

Figure 2: Overview of GHG protocol² scopes and emissions across the value chain



² <https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf>.

In the BFFI approach for listed equity, scope 1, scope 2 and scope 3 upstream are included. This is different from some approaches in carbon accounting where scope 3 is not always fully included. However, when assessing the impact on biodiversity, it is crucial to take the full scope 3 upstream into account since the highest biodiversity impact often takes place at the beginning of the supply chain. When analyzing the biodiversity impact of listed equity, Scope 3 downstream (the use phase of the products produced by companies) is often excluded due to a lack of data. Downstream impact data would need to cover the use phase for hundreds of companies, each producing hundreds of products. For project finance or an assessment of an individual company, scope 3 downstream data can sometimes be modelled.

For the assessment of entire portfolio's, it is not feasible to get a list of all purchased goods (scope 3), the energy use (scope 2), and the direct emissions (scope 1). Companies are usually not publicly disclosing this kind of information. Therefore, we need another way of modelling the direct emissions (scope 1), the energy use (scope 2), and all purchases (scope 3). This can be done using background databases described in the following paragraph. When more company specific data is available, the revenue-based modelling can be replaced by company specific information. The BFFI method can also be applied to a single company. In that case the company can provide specific information, without publicly disclosing all purchased materials, and direct emissions and resource use.

2.1.2 Step 2: Assess environmental inputs and outputs

The LCA community has developed several generic databases that list the economic inputs, the emissions, and the resource use for common activities. In the case studies for this project, the EXIOBASE Input-Output (IO) database is used for listed equity, in order to obtain the environmental inputs and outputs resulting from economic activities. This database does not describe specific industrial operations, but the average activities in an economic sector and the input and output of resources in monetary terms. For 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 emit y kg of CO₂. Moreover, the EXIOBASE database includes the trade flows between sectors and countries, enabling the modeling of (average) supply chains when more accurate supply chain data are lacking. To link a loan or investment to the EXIOBASE database, the revenue generated by a company (derived from financial databases) is linked to economic sectors specified in EXIOBASE. EXIOBASE includes 163 sectors in 44 countries (27 EU member plus 17 major economies) and five rest of the world regions.

For the footprint of Agrovision, PV plant de Rietstap, and Waternet, more detailed background databases are used since more detailed company and project data was available. In these case studies we used ecoinvent and the World Food LCA Database. ecoinvent is the most comprehensive, transparent, and international database for LCA data. This database includes over 18,000 datasets with resource and environmental emission flows for processes in many areas such as energy supply, agriculture, transport, biofuels and biomaterials, bulk and specialty chemicals, construction materials, wood, and waste treatment. Such flows include inputs of land, water, energy and raw materials, and emissions to air, land, and water. Furthermore, the World Food LCA database (WFLDB) was used for specific agricultural processes used in the Agrovision footprint.

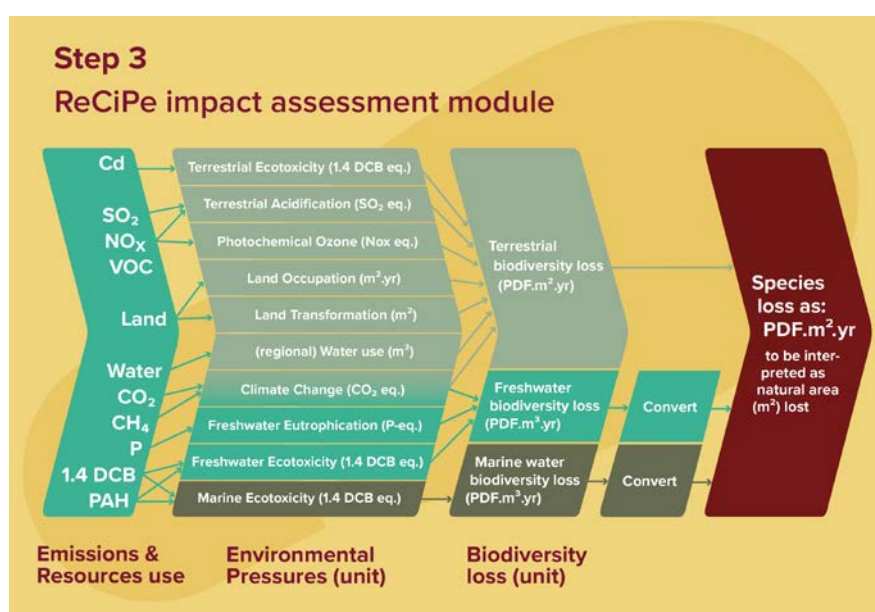
2.1.3 Step 3: Assess environmental pressures and the impact on biodiversity

Translating resource use and emissions into biodiversity loss is a two-step process based on the 'ReCiPe 2016' methodology. The ReCiPe 2016 methodology is a pressure-impact model which is based on scientific data and is widely used internationally. First, the resource use and emissions from step 2 are translated into 'midpoint' impact categories like climate change, acidification, eutrophication, etc. by means of so-called 'characterization factors'. For example, 1 kg of emission of Methane equals 34 kg of Carbon dioxide emissions in terms of global warming potential. Next, these mid-point impact categories are translated to the 'endpoint' category of Biodiversity impact. The biodiversity loss is expressed in PDF.m².yr. 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 kind³. This percentage is calculated with the surface area or water volume, and the time⁴.

Please note that PDF, area size and time are linked and interchangeable. If we get a result of 100 PDF.m². year, this could mean we may have a complete loss (PDF=100%) of biodiversity on an area of 100 m² during a year, but it could also mean a loss of 10% of the species on an area of 10m² over a period of 100 years. To simplify the presentation of the footprint results, the time is set to one year, and the PDF is set to 100% (all biodiversity is lost). This allows us to express the result as *the area (in m²) where all biodiversity is lost during one year*. An overview of the biodiversity related impact categories of the ReCiPe pressure-impact model is presented in Figure 3.

Figure 3: Biodiversity impact framework of ReCiPe



2.1.4 Step 4: Interpret the results and take action

The insights generated from the biodiversity assessment can be used to understand the impact of loans and investments on biodiversity: what are hotspots of potential impact, what are the drivers of this impact and what can be done to avoid or minimize negative impacts and optimise positive impacts? These insights can feed into a biodiversity policy, an engagement strategy and investment criteria for future investments. Moreover, when the impact of the constituents of a market index is known, the result can also be used as a benchmark for an investment portfolio.

There are of course limitations to the BFFI methodology and to the data used. In contrast to carbon footprinting, for biodiversity footprinting there are three elements why this footprint is more complex.

1. First there is no consensus on what needs to be measured. We use the species richness as an indicator for the health of a ecosystems, other methods use species abundance, or another indicator of ecosystem quality. There is no CO₂ equivalent for biodiversity (yet).

³ 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 an 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.

⁴ Example: If a farmer wants to produce 1 kg of corn, a certain area is needed, 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 damage has three elements: a potentially disappeared fraction, a surface area in m² and a time element, expressed in years. For a CO₂ emission this is 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.

2. Second, many drivers have an impact on biodiversity, there are multiple environmental problems leading to a loss on biodiversity and effects are local instead of the global impacts of a relatively small number of different greenhouse gasses.
3. Third, data is scattered over many sources and often incomplete. That is why a large part of the footprint calculation is still based on 'background data', not on the environmental data of a specific company or supplier. This also means that best practices of individual companies are not yet reflected in the footprint (only in the sector average). When company/supplier-specific data is available, the background data can be replaced by specific information. We do not always know where impacts take place, while this is very relevant.

The best we can offer is a compass which shows the approximate direction. Precision can be improved when more data become available, but it will never be perfect.

3 The Cases

In this project four case studies were executed:

- Achmea IM, ASN, a.s.r. asset management, APG and ING participated in the calculation of the biodiversity footprint of the constituents of the [MSCI World Index](#). The MSCI World Index captures large and mid-cap representation across 23 Developed Markets (DM) countries. With 1,562 constituents, the index covers approximately 85% of the free float-adjusted market capitalization in each country.
- FMO explored the biodiversity impacts of their loan to **Agrovision**, a grower, packer, and shipper of fruits and vegetables from Peru.
- ING conducted a biodiversity footprint of their loan to the open field solar PV installation "**De Rietstap**" in the Netherlands.
- NWB Bank participated in a company footprint of **Waternet**. Waternet is the water company for the municipality of Amsterdam and surrounding area. It is the only water company in the Netherlands that is dedicated to the entire cycle, since Waternet is managing water defenses and treatment of water in the area of the regional public waterboard *Amstel, Gooi en Vecht*.

The results of the case studies are described in this chapter.

3.1 Biodiversity footprint the constituents of the MSCI World Index

The E from environment in ESG reporting stands for more than just climate change. Financial institutions are increasingly interested in the biodiversity impact of their investment portfolio. Once the biodiversity impact of an investment portfolio is known, the interest to analyze the result against a benchmark will rise. Furthermore, this flagship index is the most widely used index by financial institutions. The MSCI World Index includes more than 1500 of the largest publicly listed companies in developed markets, so many financial institutions are interested in their footprint.

3.1.1 Scope, system boundaries and data used

The revenue breakdown by countries and sectors can be found in publicly available annual reports and financial statements. 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, but only through subscriptions from the data providers.

The resulting overview of sectors and countries/regions where a company generates its revenue is linked to the environmental inputs and outputs in the EXIOBASE database. The result of this step is a modelled overview of all emissions and resources used in the complete (upstream) supply chain of each company. It is important to realize that we do not know where the companies source their activities to. They can book a revenue in country A, but they might source their operations to country B. And in country B sits the impact. The supply chains are included using the trade flows in EXIOBASE, but we do not know how well each company matches the average trade flows. For instance, for a US based company that is using rare earth elements in its products, 80% of the rare earth elements in the supply chain will be modelled from China and 20% will be modelled from elsewhere, since China was responsible for 80% of rare earths imports in the US. It is very likely that this is a good way of modelling the impacts from mining of rare earth elements, but if a company chooses to only import from elsewhere, this is not reflected in the footprint.

For more detailed company specific calculations, detailed company data on procurement can be used to replace the sector average supply chain modelling from EXIOBASE. Since this information can be competitively sensitive this can only be done when the impact assessment is commissioned by the companies themselves. Including such data in this case study is therefore not an option.

3.1.2 Biodiversity Footprint results

Quantitative results

A first result of the footprint calculation is an overview of the companies' total biodiversity footprint expressed in PDF.ha.yr (which can be simplified to ha). In this list we find, not surprisingly, that the biggest companies also have the biggest footprint. To account for the (large) differences in revenue, the results are also expressed in biodiversity impact per euro revenue. This metric (expressed in m²/€), provides investors with an indication of the 'biodiversity impact intensity' of the company. Furthermore, a third metric is provided, expressing the results in square meter per invested euro. To do this, the total footprint is divided by the market capitalization of the company.

A summary of the results for these metrics (total biodiversity loss, biodiversity loss per euro of revenue, and biodiversity loss per euro invested) for all companies is shown in the table below. Table 1 shows the mean, standard deviation, minimum, median, and maximum values for the total biodiversity loss, biodiversity loss per euro of revenue and biodiversity loss per euro invested for all companies. The table shows that the mean, median and minimum are very low compared to the maximum. This implies that there are some outliers which have very high impact values.

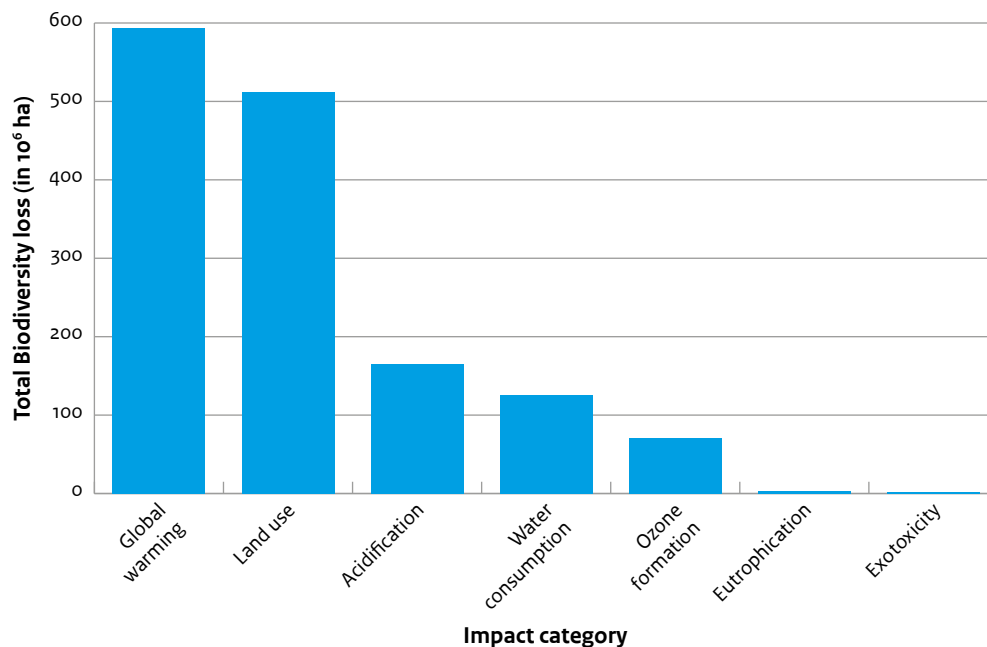
Table 1 : Summary statistics for biodiversity loss of the companies in the index

	Total biodiversity loss (in ha)	Biodiversity loss per euro of revenue (in m ² /€)	Biodiversity loss per euro invested (in m ² /€)
Mean	997 348	0.54	0.53
Standard deviation	2 963 721	1.27	2.27
minimum	170	0.005	0.0001
median	164 394	0.27	0.11
maximum	37 712 340	25.33	65.74
Sum	1 472 078 863		

The total combined biodiversity loss of the companies is 15 million km² (1 472 078 863 ha). This is around 0.56 m² per euro revenue generated and 0.34 m² per euro invested. To give 15 million km² some tangible meaning, it is slightly smaller than the land area of Russia, which is worldwide the largest country by land area. As explained, the results in m², ha or km² are derived from the unit PDF.m².yr by setting the PDF to 100% (all biodiversity is lost), and the time to 1 year (to match the reporting period). This results in 15 million km², where all biodiversity is lost for one year.

Figure 4 shows total biodiversity loss caused by all the companies in the MSCI World Index, split by driver of biodiversity loss. The main driver of biodiversity loss is impact from global warming which causes a biodiversity loss of 610 million ha and accounts for 41% of the total impact. The second major driver of biodiversity loss is land use. Land use impacts are causing a biodiversity loss of 510 million ha, which is 34% of the total impact. Thus, global warming impact on terrestrial ecosystems and land use are responsible for 75% of the total impact. The other impact categories which cause considerable biodiversity loss are terrestrial acidification (11.4%), water consumption (8.5%) and ozone formation (4.8%). For this list of companies, eutrophication and ecotoxicity have negligible impact on biodiversity loss.

Figure 4: Total Biodiversity footprint of companies in the MSCI World Index split by driver of biodiversity loss.



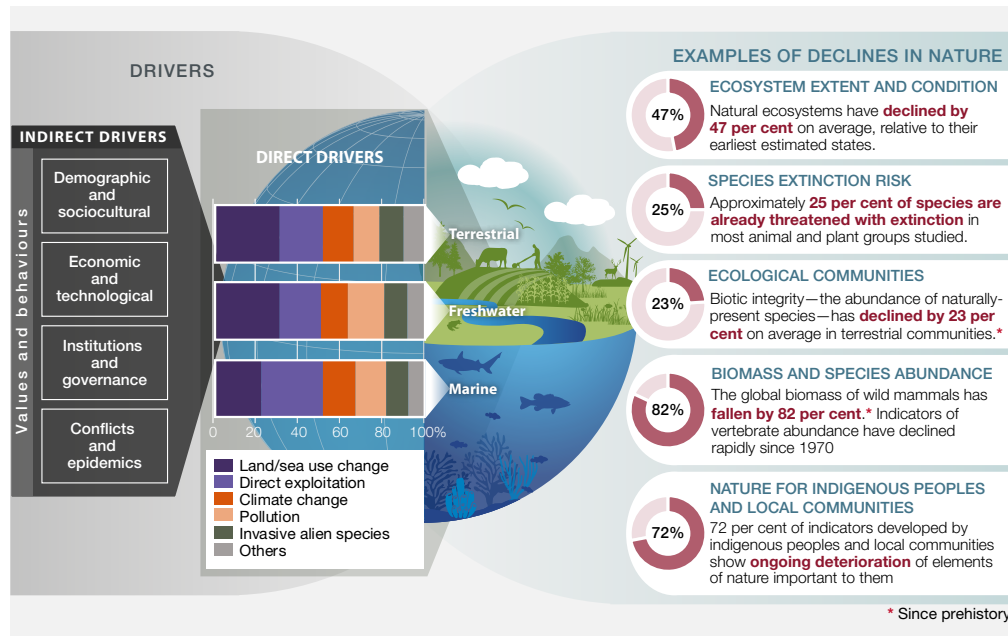
The split between drivers (such as climate change and land use) for this list of companies, is not necessarily the same globally. There are two reasons for this. First, the 1500 largest companies do not necessarily have the same impact as all human activities. Second, the ReCiPe model does not cover all drivers of biodiversity loss. The IPBES report⁵ and the Global Biodiversity Outlook⁶ list the following main drivers, the quantification for IPBES is provided in Figure 5.

- Habitat loss and degradation
- Climate change
- Excessive nutrient load and other forms of pollution
- Over-exploitation and unsustainable use
- Invasive alien species
- Others

⁵ IPBES (2019): Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany.

⁶ Secretariat of the Convention on Biological Diversity (2020) Global Biodiversity Outlook 5. Montreal.

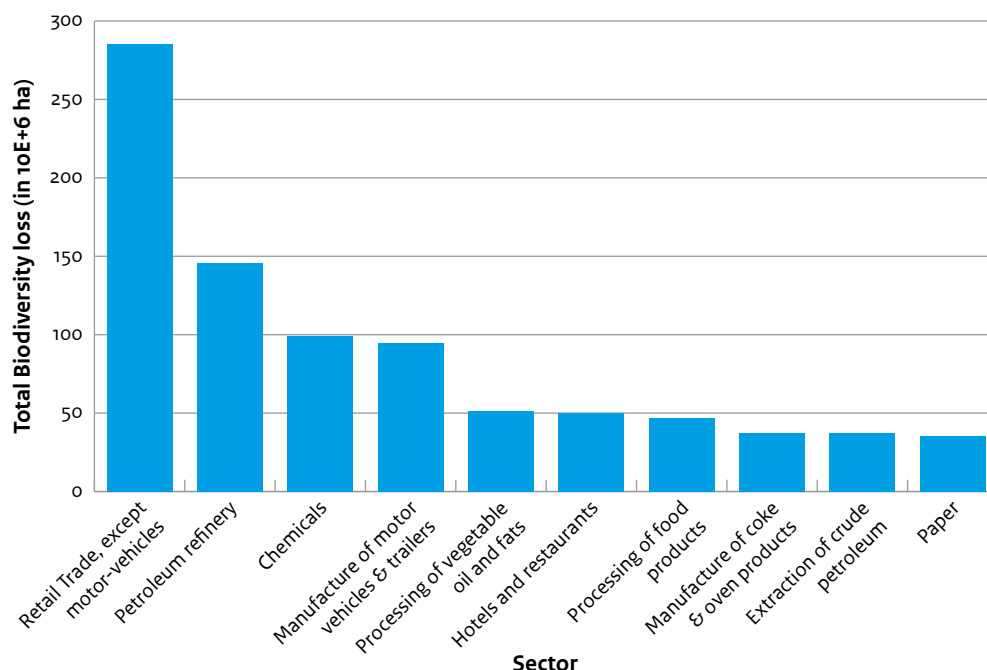
Figure 5: Drivers of biodiversity loss (from IPBES: 2019)



In Recipe, habitat loss and degradation is covered in the “land use” category. Climate change is also included in the BFFI. For excessive nutrient load, acidification and eutrophication are included. Other forms of pollution included in the BFFI are ecotoxicity and photochemical ozone formation. The water scarcity indicator is an example of over-exploitation and unsustainable use. In the IPBES report however, the focus is more on direct overexploitation such as overfishing. This type of overexploitation is not yet included in the BFFI, but it could be added in the future. Invasive alien species is also not included in ReCiPe, but it can be assessed qualitatively for individual investments.

Figure 6 shows the 10 sectors in the MSCI World Index causing most biodiversity loss. The total biodiversity loss caused by these sectors is 884.4 million ha which is equivalent to 59% of total biodiversity loss of all companies. The sector causing the highest biodiversity loss is “retail trade, except motor-vehicles”. Big retail companies with very high revenues operate in this sector and as a result the overall impact in retail trade is very high at 281 million ha (18.7%) of total impact. Sectors such as “Petroleum refinery”, “Chemicals production”, “Manufacture of coke and oven products” also cause a high impact because these are highly energy intensive processes with a high carbon intensity. Lastly, sectors like “Processing of vegetable oil and fats”, “processing of food products” and “Hotels and restaurants” require a lot of land in their supply chain and therefore their impact on biodiversity is very high.

Figure 6: Biodiversity loss caused by sectors with the highest biodiversity impact.



Limitations

It must be realised that the footprint calculation has both 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 (which was not feasible for the 1500 companies in this case study).
- The purchasing, resource use and emission profile are based on revenue generated per sector and country or region, not on company specific data.
- There are several databases available for company revenue data. These databases from ESG providers linked publicly available revenue reporting to (semi-) standardized sector classifications. These sector classifications are do not always match the actual activities of the company very well. We found this was particularly the case for utilities as they are sometimes listed as “heat producers” and/or “distribution and trade of electricity”. A detailed check on each company should be done to make sure the reported sectors match the activities of the company.
- The datasets on environmental inputs and outputs in the background data are industry averages and not supplier specific. So a company can book a revenue in country A, but they might source their operations to country B. And in country B actually sits the impact. The supply chain impact is modelled using average trade flows so companies with very different supply chains compared to their sector might have a different footprint.
- 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 why.

3.1.3 Main conclusions

The footprint provides the following key takeaways:

- It is possible to quantify the biodiversity impact of large indices for listed equity.
- The availability, quality, and structure of data on revenue by sector and region (used to identify the economic activities a company is involved in) differ between different financial databases.
- Outliers in the background data or incorrect links from the sectors in the revenue data to the sectors in the input-output-tables may have a strong influence on the results. For this reason, some companies needed to be removed from the results.
- Even though the footprint results should be interpreted with care, the results do provide a valuable input for the following applications:
 - Calculating a footprint for companies in an investment portfolio that match the companies included in this case study.
 - Comparing the impact of a portfolio with the impact of this group of listed companies: use as a benchmark.
 - Identifying biodiversity impact hotspots as a means of priority setting. What sectors or companies to focus on first from a biodiversity point of view?
 - Informing investment decisions: What sectors and companies have a relatively low or high impact on biodiversity and why? What does this mean from an investment point of view, taking into account the biodiversity targets of the financial institution (like a no-net-loss)?
 - ESG policy/Engagement: what are the key topics to be addressed from a biodiversity point of view when looking at these sectors and companies?
 - Achieving biodiversity targets: how is the biodiversity footprint of a portfolio changing in time, following biodiversity-relevant investment decisions? To see changes in portfolio impact over time, investors would need real company specific impact data, to reflect the impact of companies addressing the causes of biodiversity loss.

3.2 Biodiversity footprint of Agrovision

FMO invests in Agro Vision Peru SAC ('Agrovision'), a high growth fruit farming company with large-scale land and water assets and operations based in Northern Peru. Through licenses and strategic relationships with leading breeding programs globally, Agrovision produces conventional and organic **blueberries, table grapes, asparagus, and avocados**. It produces premium varieties of blueberries, making it the company with the most diverse offering of premium and proprietary commercial varieties in Peru. The vertically integrated grower-packer-shipper company is Global GAP, SMETA, FSMA certified and has Asia, North America, and Europe as key export markets. Agrovision not only produces the fruits mentioned, but also implements a reforestation project converting dry forest land and into a forest cover.

3.2.1 Scope, system boundaries and data used

The first step is scoping the activities to be included in the analysis (both positive and negative). The following activities are included:

- Direct land use and land use change from planting of crops and reforestation.
- Production of seedlings.
- Production of fertilizers and pesticides.
- Emissions resulting from application of fertilizers and pesticides.
- Drip irrigation.
- Tillage operations.
- Electricity, heat, and water use.
- Housing and transport of employees.

The basis for the calculations is the annual biodiversity impact of Agrovision. The analysis ends at the farm gate, therefore packaging and international shipping are not included.

3.2.2 Biodiversity Footprint results

Quantitative results

Figure 7 provides an overview of total biodiversity footprint of Agrovision. The chart shows the impact of different crops, transport and housing of employees, ancillary materials used at the facility and the impact of reforestation. The total biodiversity loss due to the crops, housing and transport of employees, and ancillary activities is 1168 ha. However, on an area of 1978 ha, a reforestation project converts dry forest land into a forest cover. It is assumed that the biodiversity restoration time of the reforestation activities takes 35 years, so the positive impact on biodiversity is allocated over that period. A shorter restoration time would result in a higher positive impact, during a shorter period. In the current calculation, the reforestation project results in an annual positive biodiversity impact of 1285 ha (shown as negative loss in Figure 7). The Agrovision staff is expecting a full restoration in 25 years, so the results should be interpreted as a conservative estimate of the positive effect on biodiversity.

The net positive biodiversity impact of the project is 117 ha. Please note that, since biodiversity loss is a location specific impact with location specific consequences, the biodiversity loss in one area cannot just be compensated by a biodiversity gain in another area. For this reason, negative impact and avoided or positive impact should always be reported separately.

The crops that are responsible for most biodiversity loss are Blueberry and Asparagus, 34% and 22% respectively. The biodiversity loss due to these crops is 398 ha. Blueberry and Asparagus also take up the biggest share of the total land occupation. Blueberry is planted over an area of 1204 ha (62%) and Asparagus over an area of 504 ha (26%). Transportation of employees results in a biodiversity loss of 373 ha (32%). Buses are used to transport employees from their housing to the farm location. The remaining two crops, Grapes and Avocado cause a biodiversity loss of 69 ha (6%) and 33 (3%) ha, respectively. Biodiversity loss caused due to housing of employees is 36 ha (3%).

Figure 7: Agrovision Biodiversity Footprint, results are expressed in hectare (ha) where all biodiversity is lost during one year. This unit is derived from the unit $\text{PDF.m}^2.\text{yr}$.

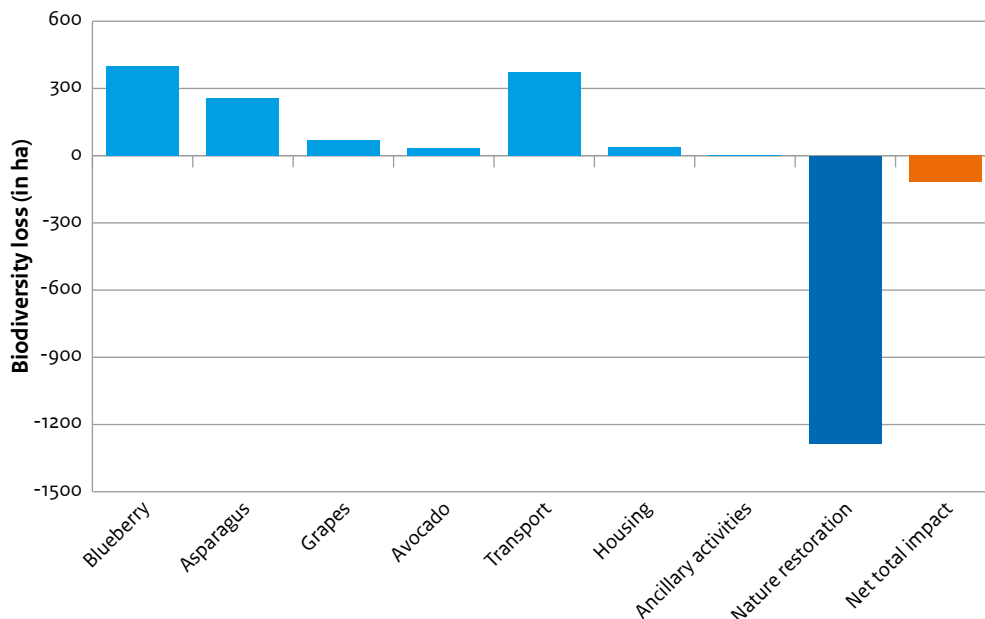
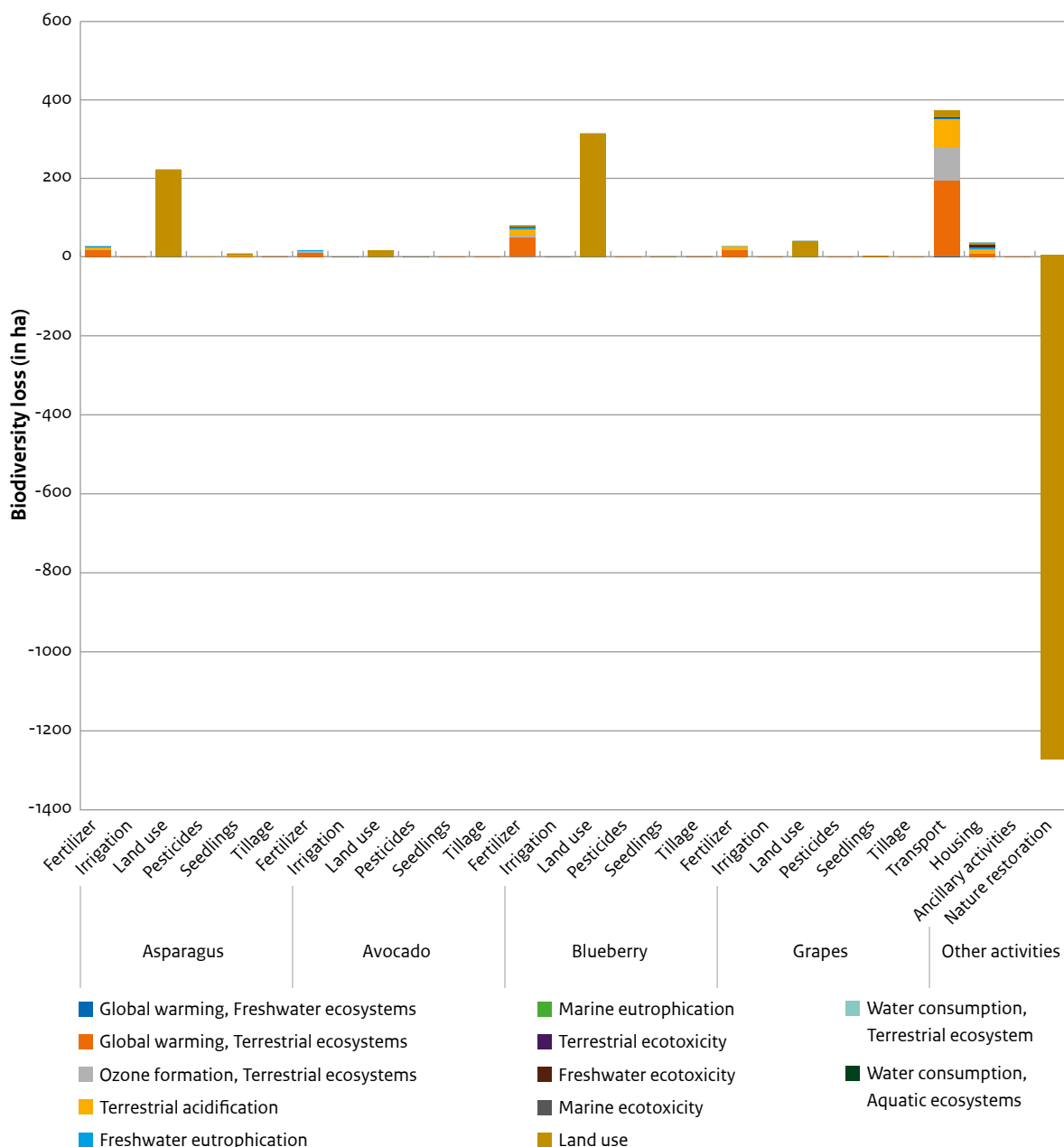


Figure 8 shows the biodiversity loss due to different processes involved in the production of crops. It is the same chart as Figure 7, but the results are more detailed, and the impact is split by driver of biodiversity loss. We already identified the main sources of impact, Blueberry and Asparagus crops and transportation of employees.

The main drivers of biodiversity loss are the transportation of employees and direct land use impacts for the crop production. The highest contribution is coming from the blue berry crops which causes a biodiversity loss of 398 ha (34%) out of the total negative impact (1168 ha). Blueberry crops are planted over an area of 1204 ha so the high biodiversity loss was to be expected. The other major driver of biodiversity loss is the impact of Asparagus crops, 258 ha (22 %). The biodiversity losses from Grapes and Avocado is 69 ha (6%) and 33 ha (3%) respectively. The total impact of aal crops is 758 ha (65% of aal negative impact). The total direct land use impact of crops causes a biodiversity loss of 593.4 ha (78 % of all negative impact from crops). The biodiversity loss resulting from other activities in crop production like seedlings for crops, irrigation, fertilizers, pesticides, and tillage is small compared to the direct land use impacts. The biodiversity losses due to other processes involved in crop production are: 150 ha (20%) due to fertilizers, 10 ha (1.4%) due to seedling production, 3 ha (0.4%) due to tillage activities, 0.7 ha (0.1%) due to pesticides and 0.2 ha (0.02%) due to irrigation.

The total biodiversity loss is dominated by land use impacts in crop production. Limited amounts of fertilizer and pesticides are used. Apart from direct land use, the transportation of employees has a relatively high impact on biodiversity. The main driver of biodiversity loss is the global warming impact caused by GHG emissions from the buses. Providing low carbon transport for employees could therefore reduce this biodiversity loss. Another source of impact is the production and use of fertilizer which causes global warming and acidification. An overview is provided in the graph below.

Figure 8: Agrovision Biodiversity Footprint, results are expressed in hectare (ha) where all biodiversity is lost during one year, and split by both drivers and processes. This unit is derived from the unit PDF.m².yr.



Limitations

It must be realised that also this footprint calculation has certain methodological and data-related limitations. Apart from the limitations mentioned in paragraph 3.1.2 (modelling of biodiversity impact, impact drivers not yet covered by the BFFI, use of background data) the following limitations apply:

- The modelling is using land use classes and expected biodiversity impact. These are generic land use types such as industrial area, agricultural land, grassland, production forest etc.
“Transformation from dry forest” does not have a characterization factor, which means that the closest land use type needed to be used.
- For some crops, specific datasets are not available. Thus, generic or proxy datasets are used. For example, to model the impact of the production of blueberry seedlings, a proxy for strawberry seedlings was used.
- It was assumed that the reforestation process occurs over a period of 35 years based on average restoration times from ReCiPe. The positive impact of the reforestation process in year one was allocated by

dividing the overall reforestation impact by a factor of 35. However, the real time period over which reforestation occurs may be different. It is possible to adapt the restoration time. A lower restoration time will lead to a higher positive impact per year, but the period for which a positive impact can be reported will be shorter. In this case the expected restoration time is 25 years, so the default 35-year restoration time is a conservative estimate.

- The analysis only includes impacts from the agricultural activities, the housing on the farm and the transport of the employees. The packaging and the international shipping are excluded because we do not expect major biodiversity impact for these activities. These activities can be included, but there was limited time available per case study.

Qualitative results

Invasive species

Important reasons for the introduction of invasive species are land use change, climate change and international supply chains/transport. The project leads to land use change, including a change from degraded land to agriculture and reforestation. Depending on the agricultural practices applied and trees replanted, invasive species could be introduced, but this is not expected in this project. International transport of the products produced could contribute to the spread of invasive species, depending on the way of transport (e.g. ballast water in ships) and enforcement of phytosanitary standards. The overall impact that can be attributed to Agrovision is likely to be small compared to other impacts.

Overexploitation

This driver of biodiversity loss is linked to fisheries, agriculture, forestry operations and products with biobased materials. The impact of overexploitation is not expected to be relevant for this project (looking at the inputs used, like seedlings etc.).

3.2.3 Main conclusions

The footprint provides the following key takeaways:

Overall, Agrovision has a net positive impact on biodiversity of 117 hectares (1.17 square kilometer). The biodiversity loss is 1168 ha while the biodiversity gain due to reforestation project is 1286 ha. Most of the negative biodiversity impact is caused by Blueberry and Asparagus crops, and by the transportation of employees. These 3 activities are responsible for 1103 ha (88%) of the total biodiversity loss. Direct land use for the 4 crops together causes a net biodiversity loss of 593 ha (51 % of all negative impact).

We see a relatively low impact from fertilizer use, use of pesticides and irrigation activities. It seems that the better management practices implemented by Agrovision to reduce fertilizers and pesticide use, and the implementation of drip irrigation is paying off, since these types of impact are usually the main source of impact in agricultural products.

3.3 Open field solar PV installation "De Rietstap"

ING has provided a green loan through ING Groenbank to private company Greenspread for the construction and exploitation of solar park De Rietstap. The loan was provided in 2019 and the solar park is operational since 2020. The main shareholder and developer of the project is Greenspread Investments B.V. ("Greenspread"). During the lifetime of the project Greenspread has been responsible for the project asset management. Since March 2021 Greenspread has combined forces with Rooftop Energy, Solaris Industria, CT Energy and Ealyze to become one company with the new name 'Groendus'.

Figure 9 : An impression of the solar park.



The De Rietstap solar park covers 2.5 hectares of previous agricultural land. The solar park consists of 5732 solar panels with an installed capacity of 2.18 MWp. The solar park will produce approximately 2 mln kWh per year, this should cover the electricity use of roughly 700 households. The park fits within the previously realized parks by Greenspread because this park also takes the environment into account. For example, a green area is laid out, flowery mixtures are sown and sheep graze so that there is maximum added value for the environment. This is Greenspread's second ground-based solar park.

3.3.1 Scope, system boundaries and data used

In the first step an analysis is made of the economic activities that are linked to the investment. An important question that needs to be answered is what scopes need to be included in the footprint. For example, the Solar park occupies a certain amount of land, which can be considered a direct impact and can be classified as scope 1 impact. In this project there are no scope 2 impacts, because scope 2 impacts are the impacts from purchased energy. Scope 3 upstream impacts are all the purchases needed to realise the project. For example, the production of solar panels requires the input of Silicon material. The impact of producing Silicon material is included using background data from the Ecoinvent database. The background datasets include all activities in the supply chain including the mining of the raw materials.

For De Rietstap, we consider the direct impacts resulting from land occupation and land transformation, the impacts resulting from the production of solar panels, the mounting structure and the inverter and the avoided impact resulting from the generation of green electricity (scope 3 downstream).

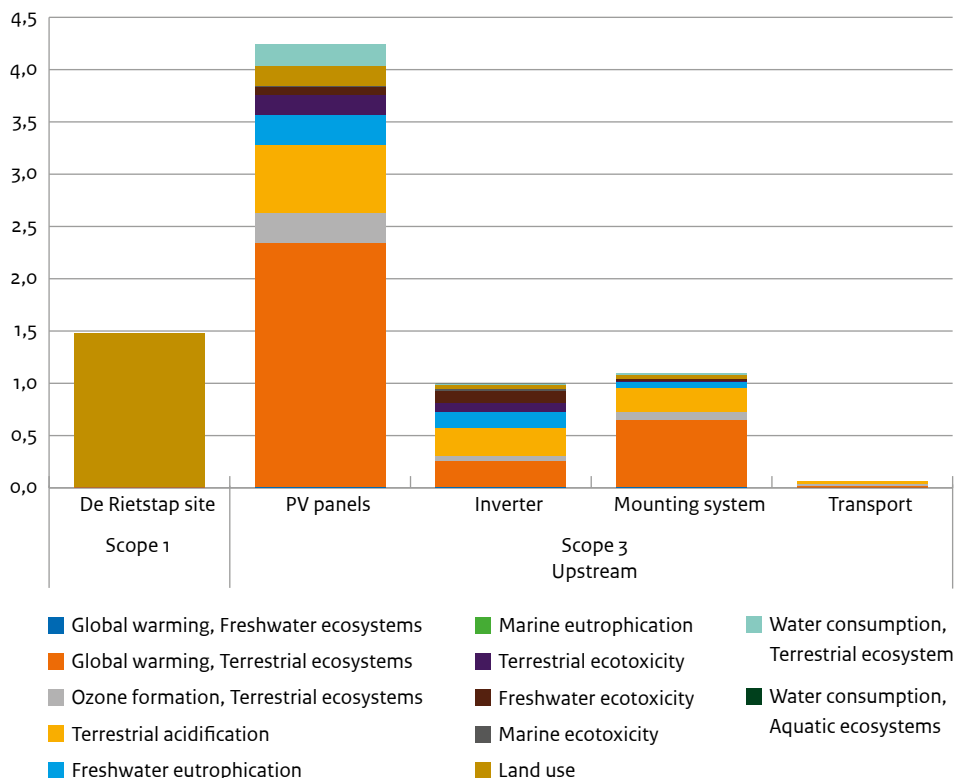
The footprint results for De Rietstap are based on one year of operation. The activities modelled include the full supply chain from the raw material extraction, the production of the crystalline silicon wafers, the assembly of the panels, transport, production and installation of the mounting structure and the additional electrical components (inverters). The assumed lifetime of the panels and mounting structure is 25 years, and the inverters are expected to be replaced once during the lifetime of the project.

3.3.2 Biodiversity Footprint results

Quantitative results

Figure 10 shows the biodiversity impact resulting from the different activities involved in the realization of the solar park. The impact is broken down by scope (scope 1 and scope 3) and scope 3 upstream is divided into the different solar park components (PV panels, inverter, and mounting system). Transport is also reported separately. The impact includes land use at the site and the production and transport of solar panels, the inverter, and the mounting system. There are no impacts reported for scope 2 since scope 2 entails the impact from energy use during the operation; De Rietstap is producing energy rather than consuming energy. The results are also split by driver of biodiversity loss (land use change, climate change, acidification, etc.). The total negative biodiversity impact of one year operation of the solar park is 7.9 ha where all biodiversity is lost during one year. This unit is derived from the unit PDF.m².yr.

Figure 10 : Biodiversity impact (ha) where all biodiversity is lost during one year of Solar PV park De Rietstap. The impact is broken down by driver of biodiversity loss. This unit is derived from the unit PDF.m².yr.



The main source of impact is the production of the PV panels. About 50% of the impact from PV panel production is caused by GHG emissions leading to climate change. Most of these emissions are related to the crystalline silicon wafer production which is an energy intensive process.

The impact on the site level is caused by the land use of the park itself. The impact is modelled because there is no data available on the site level species richness before and after realisation of the solar park. Modelling is possible using scientific data on the different levels of biodiversity for different land-use types. However, since no scientific data are available for the land-use type 'solar park', a calculation is made for two different scenarios:

1. Land use by the solar park is comparable to an industrial area (hardly any biodiversity left).
2. Land use by the solar park is comparable to grassland (the level of biodiversity is higher than an artificial area).

The land use type before realisation of the solar park was agricultural land. The result for the first scenario (agricultural land is changed into an industrial area) is shown in Figure 10. In a sensitivity analysis we also calculated the impact from scenario two. This resulted in a lower direct land use impact of 0.86 ha (compared to 1.5 ha in the baseline scenario). Figure 10 can therefore be interpreted as a worst-case scenario.

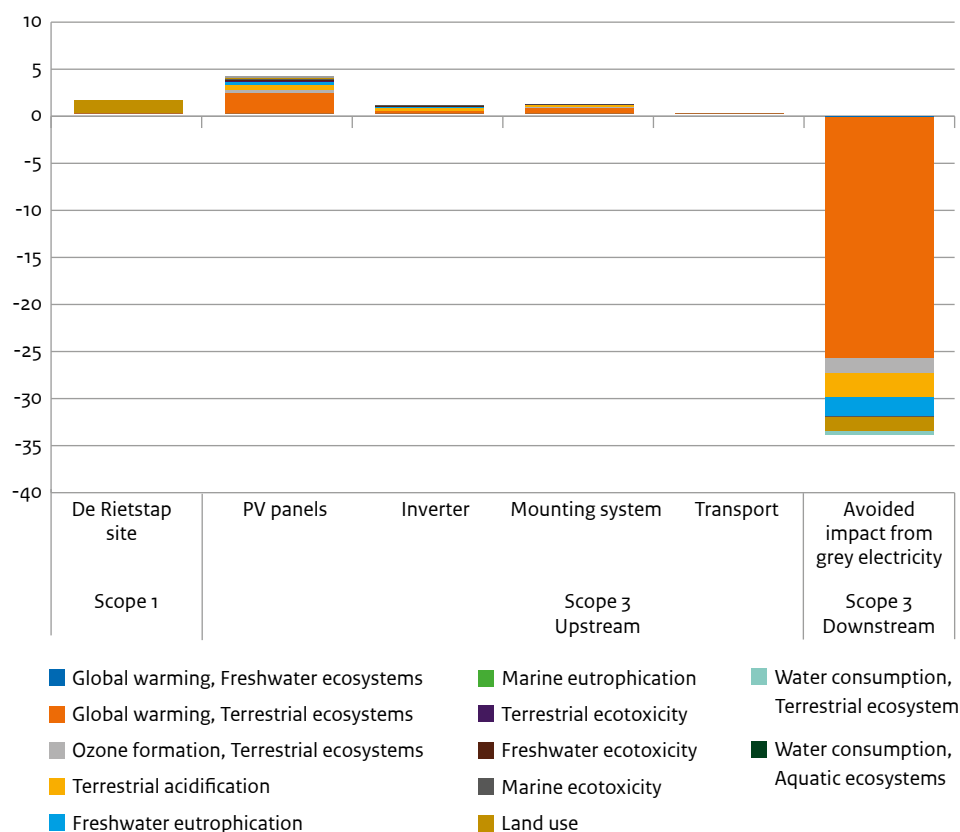
The mounting system and inverters are less important for biodiversity loss. For the mounting system, GHG emissions from the aluminium production are the main driver of biodiversity loss.

Avoided Biodiversity Impact

The main benefit of renewable energy technology is the ability to replace fossil fuel-based electricity generation. Therefore, we compare the energy produced by the solar park to the current Dutch electricity generation mix. The following chart shows the impact of De Rietstap as shown in Figure 10 alongside the avoided impact from the Dutch electricity mix. The comparison is based on the total electricity produced by De Rietstap in one year. 'Avoided impact from grey electricity' represents the avoided impact of producing the same amount of energy with the average Dutch electricity mix.

The results show that the avoided impact from grey electricity outweighs the impact of electricity production from De Rietstap (the sum of impacts in scope 1 and scope 3 upstream) by more than a factor 4. Climate change is the decisive driver, which is to be expected since the current Dutch electricity production system is highly carbon intensive. Furthermore, there are some avoided impacts on acidification. These are avoided emissions of acidifying substances such as sulphur dioxide (SO₂) and nitrogen oxides (NO_x) which occur when fossil fuels are burned. We also see some avoided land use impact from coal mining.

Figure 11: Biodiversity impact (ha) where all biodiversity is lost during one year of operation of Solar PV Park De Rietstap. This unit is derived from the unit PDF.m².yr. The results are broken down by driver of biodiversity loss, including avoided impact from grey electricity production.



Limitations

Apart from the limitations mentioned in paragraph 3.1.2 (modelling of biodiversity impact, impact drivers not yet covered by the BFFI, use of background data) the following limitations apply:

- The modelling is using land use classes and expected biodiversity impact. These are generic land use types such as industrial area, agricultural land, grassland, production forest ect.
“Grassland with solar PV” does not have a characterization factor. The land use class ‘industrial area’ is used as an alternative. Impacts from direct land use and options to reduce this impact need to be assessed qualitatively.
- Development of datasets takes time so not all data matches the latest technological development. This is relevant for solar PV panels and inverters because of the fast pace of developments in that sector.

Based on these limitations, the negative impacts in the footprint results are likely to be an overestimation of the actual negative impact.

Qualitative results

Invasive species:

Important reasons for the introduction of invasive species are land use change, climate change and international supply chains/transport. The avoided impact from grey electricity reduces climate change; the project leads to land use change; once the park is established, no international transport is needed. Based on this, no significant negative impacts from invasive species are expected.

Overexploitation

This driver of biodiversity loss is linked to fisheries, agriculture, forestry operations and products with biobased materials. The impact of overexploitation is not expected to be relevant for this project.

Analysis of direct land use impacts

Table 2: Overview of direct land use impacts

Negative effects	Positive effects & options to reduce negative impacts
Reduction of light	Differentiation in light
<ul style="list-style-type: none"> • less flowery vegetation • less biomass • less organic carbon in the soil 	<ul style="list-style-type: none"> • Negative effects can be compensated with the right vegetation (herb rich grassland) • Differentiation in light can lead to more variation in flora and fauna
Water management	
<ul style="list-style-type: none"> • Unequal distribution of precipitation may lead to erosion and nutrient leaching 	<ul style="list-style-type: none"> • Less evaporation below the panels in summer • Possibility to raise the groundwater level is good for certain species • Higher groundwater levels on peat soils decrease GHG emissions from peat oxidation
Field setup	
<ul style="list-style-type: none"> • Open field solar PV projects in natural areas can damage biodiversity. • Closed fences can lead to fragmentation. 	<ul style="list-style-type: none"> • More space between panels reduces negative impacts on biodiversity • Closed fences can reduce disturbance • Solar PV on previously agricultural land can increase biodiversity levels compared to monocultures • Field margins, or buffer strips, are ideal locations for biodiversity enhancement and may benefit plants, invertebrates and ground nesting birds as well as reptiles and small mammals
Sources:	
<ul style="list-style-type: none"> • Zon in landschap en landbouw (2018) Brochure Zonnepanelen en Natuur • Klaassen, R. et al. (2019) Literatuurstudie en formulering richtlijnen voor een ecologische inrichting van zonneparken in de provincies Groningen en Noord-Holland • RE (2014) Biodiversity Guidance for Solar Developments. Eds G E Parker and L Greene. 	

Greenspread was already implementing the following measures to mitigate the negative direct land use impacts. An agricultural area with limited natural growth (trees, hedges) was be changed into a grassland covered by solar panels, grazed by sheep and with limited growth on the sides (sunflowers, trees, flower beds, hedges, wood rows). Part of the trees remained. A nature scan has shown that the area is of no specific conservation value: no protected plants and no habitat for protected animals (which have occasionally been spotted). The area does not play an important ecological role in the surrounding area and more distant nature areas (Natura 2000). Greenspread states that there is a distance between the rows of approximately 5 meters. The rows themselves are approximately 3.8 meters wide. Rainwater falls in between the rows on the ground and water that falls on the panels then falls to the ground through a gap between the individual panels. Spacers are mounted for this. Sun light reaching the ground is limited but still enough to allow shade loving herbs to flourish. The vegetation surrounding the solar park is deliberately highly diverse, resulting in flowers and fruits during a large part of the year, benefiting insects, birds and small mammals. Grazing by sheep will contribute to fertilization of the soils below the solar panels. The effect of the fertilization can be positive or negative, depending on the site-specific conditions, because fertilizations can also lead to acidification and/or eutrophication.

3.3.3 Main conclusions

The footprint provides the following key takeaways:

- Global warming, land use and terrestrial acidification are three of the main drivers of biodiversity loss for the production of PV panels, the inverter and the mounting system. For each of the three components, global warming is related to energy use during production. Terrestrial acidification is mainly linked to emissions of sulfur dioxide and nitrogen oxide to air resulting from the production of energy needed for the extraction and processing of silicon and the manufacturing of mono- and multi-crystalline silicon wafers.
- The site level impact is the second biggest impact compared to the production of PV panels, but the impact can be lower when measures are taken to improve the level of biodiversity.
- The influence of transport of the different components is relatively small.
- The avoided impact from grey electricity outweighs the negative impact of the solar PV plant.

3.4 Waternet

NWB Bank provides loans to Waternet. Waternet is a water company, providing clean drinking water to Amsterdam and the surrounding area and water management services including maintenance of dykes and treatment of water to waterboard Amstel Gooi en Vecht. Waternet is dedicated to sustainable management of the entire water cycle. Waternet's activities include the supply of drinking water, wastewater collection, wastewater treatment and water system management. Waternet provides a safe, clean, and sufficient supply of water for nature areas and human consumption.

Sustainability is one of the strategic themes of Waternet, including carbon, circularity, social aspects, and biodiversity. Waternet manages land around its water treatment plants and other buildings and is responsible for the management and maintenance of dikes, viewing paths (along water ways) and ditches. Such terrains are increasingly developed and managed with an eye for biodiversity. Moreover, biodiversity friendly measures are taken regarding Waternet's buildings, benefiting bats and birds.

In this case study, the biodiversity footprint of both the drinking water and the water management activities is based on the scope 1, scope 2 and scope 3 input data in the Waternet carbon footprint. The direct biodiversity impact and indirect biodiversity impact included are described in the paragraph 3.4.1 and input data is summarized in Table 3. The following impacts on biodiversity are not quantified in this biodiversity footprint:

- The core activity of Waternet is cleaning of water. Discharging untreated water to surface water will have a negative environmental impact. The focus of this footprint is on the impact of the inputs of the operational activities, not on the output. Additional analysis is needed to include the avoided impact of

not discharging untreated sewage water to surface water.

- Besides the avoided impact of the effluent water, the remaining negative impact of effluent water (nitrogen, phosphate, chemical oxygen demand and solids) is not included. Both the avoided impact for not discharging sewage water and the remaining impact from the effluent can be included using direct data and the ReCiPe impact assessment model.
- Avoided or positive impacts from other water management tasks, like dredging and deepening of ditches are also excluded. These effects are very complex and it is not possible to model all the complexities are by the impact assessment model used in this study.
- GHG emissions from peat oxidation are estimated to be an order of magnitude bigger than all carbon emissions as a result of Waternet's operations. The water level has a big impact on the amount of GHG emissions as a result of peat oxidation. Higher water levels may reduce those emissions⁷.
- Higher ground water levels and removal of carbon from ditches reduce GHG emissions from water (such as methane). These measures are also expected to have a positive impact on water quality⁷. Better water quality is likely to have a positive effect on biodiversity.

This case study should therefore be seen as a start of a biodiversity footprint. When determining the key impacts and the priority in reducing negative impact, it is important to consider that this analysis only includes the biodiversity impact of the inputs of the operational activities.

3.4.1 Scope, system boundaries and data used

In the first step of this case study, an analysis has been made of the activities that have a biodiversity impact (both positive and negative). For this project, the impact is calculated for 3 scopes: the whole supply chain of all purchased goods is included in scope 3 upstream, the energy used is covered in scope 2 and the own operations of Waternet are covered in scope 1. In Waternet's carbon footprint, only a part of the scope 3 downstream impacts are included. Scope 3 downstream impacts included are sludge and residue transport. For the biodiversity footprint, several other scope 3 downstream impacts are included a qualitative way, since the impacts downstream are difficult to quantify in the limited time available for the case study.

It is likely that site specific measures taken with the local knowledge of the ecosystems have a significant positive impact. The footprint results are based on one year of operations of Waternet (2019). The activities included are all scopes listed above for drinking water operations, sewage treatment, sewage system, water system, and overhead. The results should be interpreted with caution since land use was modelled using very rough estimates and detailed water use modelling was not possible due to time constraints. Moreover, the positive impacts resulting from water purification activities, water management activities, and contributions to reducing impacts from invasive species were not included. Without the water purification activities, untreated sewage water would be discharged, and polluted surface water would lead to biodiversity loss in de rivers such as the Vecht, Amstel, and amongst others the lakes *Loosdrechtse plassen*, *Vinkeveense plassen*, and *Naardermeer*. The current footprint only quantifies the negative effects of all inputs of the operational activities of Waternet. The positive effects of the results of those activities are assessed qualitatively. Further analysis and in some cases method development is needed to quantify these impacts.

⁷ Motelica-Wagenaar, A. M., Pelsma, T. A. H. M., Moria, L., and Kosten, S.: The potential impact of measures taken by water authorities on greenhouse gas emissions, Proc. IAHS, 382, 635–642, <https://doi.org/10.5194/piahs-382-635-2020>, 2020.

The following input data was collected from Waternet:

Table 3: Input data collected from Waternet

Scope	Input data	
Scope 1	Fuel use	
	Process related emissions	
	Land use (added with estimates, not fully complete)	
Scope 2	Electricity	
	Heat	
Scope 3 (upstream)	Material use	<ul style="list-style-type: none"> • Metals • Carbon fiber • Activated carbon • Chemicals • Concrete
	Transport of	<ul style="list-style-type: none"> • Business transport • Air travel • Sludge • Commuting
Scope 3 (downstream)	Transport of	<ul style="list-style-type: none"> • Sludge • Residues
Avoided emissions	Heat, gas and electricity delivered to grid	

3.4.2 Biodiversity Footprint results

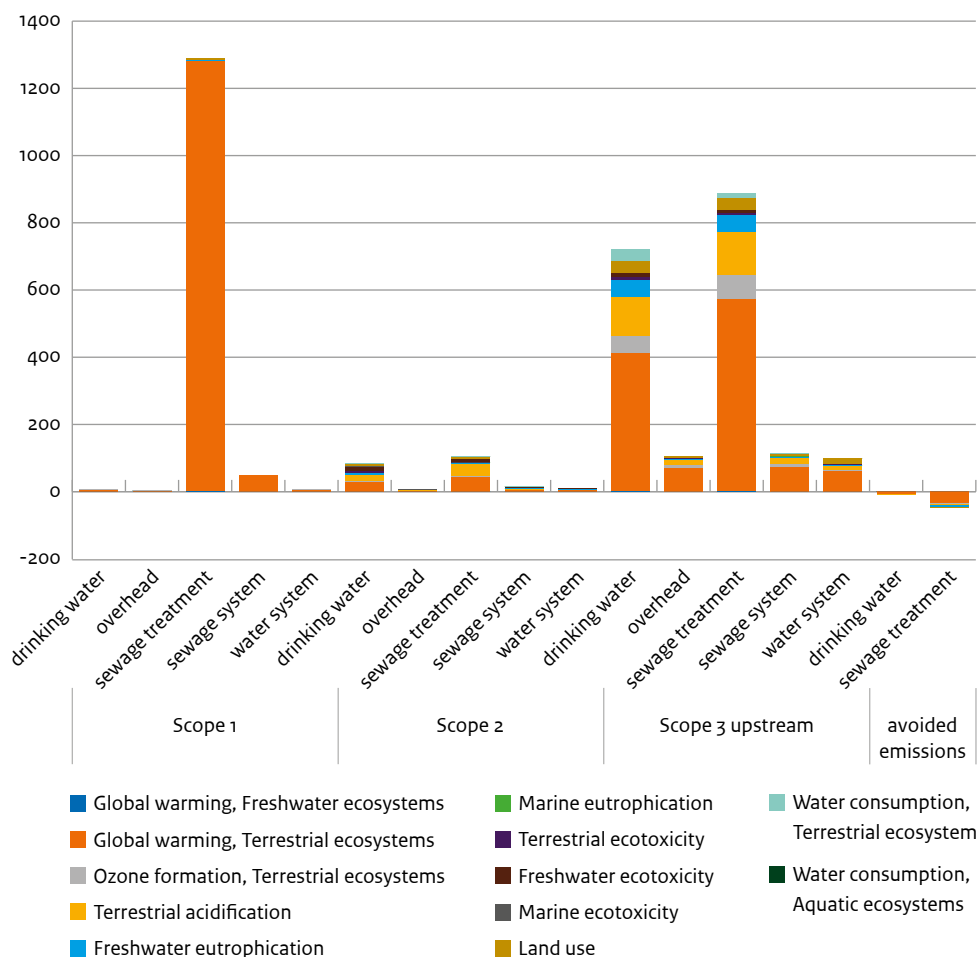
Quantitative results

The overall biodiversity loss from the operational activities included in the quantitative footprint, is 3504 hectares where all biodiversity is lost for one year. Most of the impact originates in scope 3 upstream (56%), followed by scope 1 (39%). The impact from scope 2 is limited (6%) and there is a small avoided impact from energy, biogas and heat delivered back to the grid (-2%). The total avoided impact is 61 ha.

Figure 11 shows biodiversity loss due to operational activities for all scopes and business units. The main sources of impact are sewage treatment in scope 1 and drinking water production and sewage treatment in scope 3 upstream. The main driver of biodiversity loss is the impact from global warming on ecosystems. For sewage treatment in scope 1, 99 % of the biodiversity impact is caused by climate change due to GHG emissions. In scope 3 (the impact of inputs purchased), 57% of all biodiversity impact of drinking water production is caused by climate change; for sewage treatment this percentage is 65%.

Climate change is also the main driver of biodiversity loss (75%) when looking at the total footprint of Waternet. Other important drivers are indicated in bold in figure 11. Acidification accounts for 10% of all biodiversity impact, freshwater eutrophication accounts for 4% and land use (and land use change) accounts for 3% of the impacts.

Figure 12: Waternet Biodiversity Footprint of 2019, results are expressed in hectare (ha) where all biodiversity is lost during one year, split by driver of biodiversity loss. This unit is derived from the unit PDF.m².yr.



The analysis shows that for the activities quantified in the footprint:

- The major causes of the high climate change impacts from Waternet are direct process related emissions of Methane and Nitrous oxide.
- The main cause for the biodiversity impact in scope 3 for the drinking water unit is the production of chemicals needed for the water purification process. In particular, the production of sodium hydroxide stands out.
- The main cause for the biodiversity impact in scope 3 for the sewage treatment business unit is the production of chemicals needed for the water purification process.
- The most important emissions from a biodiversity point of view are carbon dioxide (climate change), sulfur dioxide (climate change and acidification), nitrogen oxides (climate change and acidification), phosphate (eutrophication), and methane (climate change).

Limitations

Apart from the limitations mentioned in paragraph 3.1.2 (modelling of biodiversity impact, impact drivers not yet covered by the BFFI, use of background data) the following limitations apply :

- The quantitative analysis only includes the negative impacts, and more development is needed to take the avoided impact from untreated sewage water discharge, and other water management tasks, like dredging and deepening of ditches into account.
- The impact on water scarcity in scope 1 has not been included due to the challenges of quantifying this impact and time constraints. This could be an important driver of biodiversity loss, depending on the (un)sustainable use of aquifers.
- For land use in scope 1, only two water purification plants and the main office were included in the analysis. Other offices were not included.
- Compensation of carbon emissions (by Trees for All) was not taken into account in the analysis.
- The footprint is limited to scope 1, 2 and 3 upstream. The services that Waternet provides (clean water and specific efforts to increase biodiversity) were not included in the quantitative analysis due to time constraints and an expected lack of data. These impacts downstream could have a significant (positive) effect on the footprint calculation.
- The modelling is using land use classes and expected biodiversity impact. These are generic land use types such as industrial area, agricultural land, grassland, production forest etc. Since there is no specific land use class for (for example) 'sewage purification plants', the land use class 'infrastructure' has been used. The same is true for land use by Waternet where the land is managed with an eye for biodiversity. For example, for land use by dykes, grassland has been selected as a land use class, regardless of the management type. It is possible to add more detail to the modelling of land use impacts.
- Peat oxidation is not included in the modelling, but the carbon impacts outweigh the impact of the scope 1, 2 and scope 3 upstream activities.

Qualitative Results

Invasive species

Important reasons for the introduction of invasive species are land use change, climate change and international supply chains/transport. Since a waterboard will influence groundwater tables, the waterboard can have significant (positive or negative) influence on the attractiveness of areas for certain species. Moreover, water authorities play a role in the removal of invasive water plants and wildlife management in water catchment areas and in relation to the protection of dikes. This means that water authorities can play a positive impact with regard to invasive species, possibly resulting in a positive impact on biodiversity.

Overexploitation

This driver of biodiversity loss is linked to fisheries, agriculture, forestry operations and products with biobased materials. The impact of overexploitation is not expected to be directly relevant for Waternet.

Qualitative analysis of scope 3 downstream impacts

Table 4: Qualitative analysis of impacts not quantified in the calculations.

Potential impacts – drivers	Positive/negative	Remarks
Biodiversity conservation measures		
Nature-friendly development of terrains managed by Waternet, including the construction of nature friendly banksides	+/-	Positive compared to business-as-usual situation. Impact could still be negative compared to no economic activities.
Active contributions to species conservation (e.g. as part of the Dutch 'Deltaplan Biodiversiteitsherstel')	+	
Cooperation with other landowners, like farmers, in order to ensure that practices (e.g., mowing, dredging, use of pesticides) benefit water quality	+	Positive compared to a business-as-usual scenario (no cooperation)
Water management related impacts		
Improved water quality as a result of sewage water treatment, preventing polluted water from ending up in nature.	+	
Dredging and mowing activities supporting water quality and water quantity	+/-	Impact is positive when the needs of nature are in line with the needs of stakeholders in the area (social-economic needs)
Water level management has a very big influence on peat oxidation. In the carbon footprint, this impact outweighs all other activities ¹	+/-	
Water management also influences the ability of bird species to flourish	+/-	High ground water levels provide more food for birds and softens the soil, so it is easier for them to penetrate the soil.
Other water management activities regulating water quantity and water quality (e.g., use of dikes, dams and pumping stations)	+/-	Impact is positive when the needs of nature are in line with the needs of stakeholders in the area (social economic needs)
¹ Motelica-Wagenaar, A. M., Pelsma, T. A. H. M., Moria, L., and Kosten, S.: The potential impact of measures taken by water authorities on greenhouse gas emissions, Proc. IAHS, 382, 635–642, https://doi.org/10.5194/piahs-382-635-2020 , 2020.		

3.4.3 Main conclusions

The analysis shows that most of the negative biodiversity impact of Waternet can be quantified. Additional analysis is needed to quantify the avoided impact from avoiding untreated sewage water discharge in surface waters, and the negative impact from the remaining effluent. The impacts from peat oxidation can also be added to the biodiversity footprint, but it is not obvious that those emissions can be attributed to Waternet. More method development is needed to include local (positive) effects from water management tasks, like dredging and deepening of ditches or other measures. Once these important limitations are covered, the current footprint results can be put in perspective.

The results of this (limited) biodiversity footprint can be used to see what the main drivers of biodiversity loss due to operational inputs are, and which business units, processes and emissions are the main contributors of biodiversity loss. There is room to make the footprint more detailed, by collecting more detailed input data on land use and water use for instance.

Overall, according to the footprint calculation (which is not complete, see limitations), the *net* biodiversity loss due to operational inputs is 3443 PDF.ha.yr. This can be simplified to 3443 ha where all biodiversity is lost during one year. Most of the impact originates in scope 3, followed by scope 1. The impact from scope 2 is limited. The main driver of biodiversity loss is the impact from global warming on ecosystems.

The business unit with the highest impact share in scope 1 is the sewage treatment. For scope 3, there are two business units with a relatively high share of the biodiversity impact: drinking water production and sewage treatment.

The major causes of the high climate change impacts for drinking water treatment are direct process related emissions of Methane and Nitrous oxide. Therefore, efforts to reduce the impact on biodiversity should include a focus on these process related emissions.

The main cause for the biodiversity impact of the scope 3 drinking water unit is the production of chemicals needed for the water purification process. In particular, the production of sodium hydroxide stands out. The main cause for the biodiversity impact of the scope 3 sewage treatment business unit is the production of chemicals needed for the water purification process.

While Waternet cannot directly control these emissions, sourcing the chemicals from producers who produce these chemicals in a more sustainable way would contribute considerably to a reduction of Waternet's negative biodiversity impact.

These results should be interpreted with caution since land use was modelled using very rough estimates and detailed water use modelling was not possible due to time constraints. Moreover, the positive impacts resulting from water purification activities, water management activities and contributions to reducing impacts from invasive species were not included. Finally, the impact from peat oxidization was not in scope of the biodiversity footprint, but it is an major lever for the water authority to mitigate climate change impact biodiversity impact.

4 Conclusions & Recommendations

4.1 Conclusions

The case studies allowed the participating financial institutions to gain insight in the way biodiversity impact assessment works, the kind of data that is needed to conduct a footprint and how to interpret and use the results. More specifically, the project resulting in the following lessons learned:

Impact assessment methodology and data used

A clear understanding of the impact assessment methodology and data used is key for a correct interpretation of the results of the impact assessment. The cases studies confirmed that this is especially true for the following characteristics of methodology and data:

Methodology

- *Drivers of biodiversity loss included in the pressure-impact model*
Not all drivers of biodiversity loss are included in the pressure-impact model ReCiPe (neither are all drivers included in other models, like Globio or IMPACT WORLD+). An example is the introduction of invasive species. Although this driver is expected to play a relatively small role in some assessments (like the footprint of the solar park), it might play a bigger role in other assessments (like the footprint of the Water board). For this reason, it is important to take this limitation into account in the qualitative analysis and the interpretation of the results.
- *Land-use classes included in the pressure-impact model*
The ReCiPe pressure-impact model distinguishes a limited number of land use classes with related impacts on biodiversity. These land-use classes do not always capture the land-use for which the impact needs to be assessed, like the land-use of a solar park. In such cases, land-use classes closest to the land-use under investigation can be used as an alternative. Moreover, the significance of land-use impact in the total biodiversity footprint can be assessed by calculating the impact of land-use using a worst-case scenario. For example, by calculating the impact of land-use for a solar park using the land-use class 'industrial area'. This will show to what extent more specific data on the impact of land-use is likely to influence the overall footprint result.

Data

- *Data concerning the sectors and regions in which a company generates its revenue*
In case of a biodiversity impact assessment for a large number of companies, data is needed on the economic activities a company is involved in. Financial data providers offer data on the revenue generated in different sectors and regions. This data can be used in a footprint. The case study on the constituent companies in the MSCI World Index has shown that the structure and granularity of these data differ between data providers, affecting the footprint results.
- *Background data and responsiveness of the footprint result*
When company specific environmental data are not available or would be too time consuming to collect, background data from databases like EXIOBASE can be used. Because EXIOBASE data is country specific sector average data, actions taken by companies following engagement, will not be reflected in the footprint; the footprint is not responsive. This is important to realize when a financial institution is working towards a goal like 'no-net-loss' or 'net gain'.

- *Modelling supply chain data and responsiveness of the footprint result*
Data on suppliers and the environmental inputs and outputs in supply chains are often lacking. A solution to cope with this data limitation is to use modelled supply chains, based on the trade flows between sectors and countries available in EXIOBASE. This will again affect the responsiveness of the footprint, since biodiversity relevant sourcing policies of companies are not reflected in the footprint.
- *Availability of current data reflecting the level of innovation*
Environmental data from background databases can be several years old. Depending on the level of innovation in the sectors concerned this might mean that the footprint calculated is a worst case footprint: innovation is not yet reflected.

The result and use of the footprints

The case studies offered valuable insights to the financial institutions and investees concerned. Overall, the following can be concluded with regard to the footprinting results and their use.

Result

- *Climate change and land-use are major drivers of biodiversity loss*
The case studies show that climate change and land-use are by far the most important drivers of biodiversity loss. This means that policies by financial institutions to reduce the carbon footprint of investments will also benefit the biodiversity footprint, unless such carbon policies lead to trade-offs between different drivers of biodiversity loss. For example, a shift from fossil based fuels to biofuels may result in a trade of between climate change and land-use. Both are key drivers of biodiversity loss.
- *Scope 3 downstream can play an important role in the overall footprint*
Scope 3 upstream plays an important role in a biodiversity impact assessment, i.e. due to the land use in primary production (e.g. in agriculture). However, several case studies showed that scope 3 downstream may also play an important role. This is true in the solar park case where the production of green energy results in avoided greenhouse gas emissions in scope 3 downstream and in the case of the waterboard, where water purification may contribute to avoided negative impact compared to the emission of untreated sewage water (this impact could not be quantified within the scope of this project).
- *Location specific context limits the accuracy, but not the value of a footprint*
The assessment of biodiversity impact using the BFFI is based on the contribution of economic activities to drivers of biodiversity loss and modelling of the impact. Although the ReCiPe model takes into account the impacts in different biomes and water scarcity on a country level, location specific (ecological) characteristics are not taken into account. This means that the result must be interpreted with care. However, the overview of biodiversity impact hotspots in an investment portfolio and the drivers behind this impact offer an important starting point for further action (see below).

Use of the footprint

- *Insight in the biodiversity impact hot spots in a portfolio enables a focus on what matters*
The fact that location specific characteristics are not taken into account and company specific data (including data on the supply chains of these companies) is often lacking does not mean that the footprint has no value. Because the footprint shows where biodiversity impact hotspots are most likely to be located in an investment portfolio, it enables financial institutions to focus and prioritise efforts to minimise negative impacts and optimise avoided and positive impacts. Zooming in on specific investments and gathering more specific data where needed.
- *The biodiversity footprint case studies shows the similarities with a carbon footprint*
The case studies provide insight in the similarities and differences between a biodiversity footprint and a carbon footprint, creating a better understanding of what is needed to take the step from carbon accounting to biodiversity accounting.
- *The footprint result informs engagement with investees*
The biodiversity footprint shows where the highest impacts on biodiversity are located (in what sectors

and what activities?) and why (what drivers are behind the impact?). This information is key in order to focus engagement on the right sectors and ask the right questions (are the drivers of biodiversity loss adequately managed by the company?).

- *The footprint results can be used for a biodiversity policy, investment criteria and investment decisions*
Insights from the footprint on the main drivers of biodiversity loss in specific sectors can be used as an input to a biodiversity policy, to develop or adjust investment criteria and to inform investment decisions. N.B.: 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.
- *The footprint result triggers discussion on biodiversity impacts*
The case studies have clearly shown that 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.

4.2 Recommendations

The project leads to recommendations for the BFFI and developers of biodiversity footprinting tools and financial institutions interested in biodiversity impact assessment.

Recommendations for the BFFI and developers of biodiversity footprinting tools:

- Find ways to make the impact assessment methodology more accurate, for instance by increasing the number of land-use classes in the pressure-impact models used and by developing ways to include scope 3 downstream impacts in case of footprints on a portfolio level.
- Look for ways to integrate or combine footprints with location specific (ecological) data.
- Improve data quality by increasing the use of company specific data, replacing background data and update background data in the meantime.
- Make the footprint results more actionable for users by means of dashboards tailored to E&S specialists, investment officers, etc.
- Continue international cooperation to find common ground in biodiversity impact assessment and to exchange and learn from best practices.

Recommendations for financial institutions:

- Use a footprinting case study to improve your understanding of what a biodiversity footprint entails, how it relates to carbon footprinting and how you can benefit from the results.
- Use a biodiversity footprint to inform engagement and trigger discussions with investees.
- Use a biodiversity footprint as a steppingstone to put biodiversity higher on the agenda. Link the value of a biodiversity footprint to other fields of action of the organisation like a policy on the SDG and the Sustainable Finance Disclosure Regulation.
- Share experiences and best practices with colleagues, for example in international platforms such as PBAF and the TNFD.
- Do not wait for perfect data, before taking action. Steps are needed to improve data collection, data quality and data availability.

As an addition to this report, a special policy paper will be written to inform policy makers on the learning from this project. Furthermore, the lessons learned will be used in the [Partnership Biodiversity Accounting Financials](#) in their efforts to develop harmonized principles underlying biodiversity impact assessment. The case studies will also be shared on the [EU Business @ Biodiversity Platform](#) and the best practices will feed in the [ALIGN project](#).

This is a publication of:

Netherlands Enterprise Agency

Croeselaan 15 | 3521 bj Utrecht

P.O. Box 8242 | 3503 re Utrecht

T +31 (0) 88 042 42 42

E klantcontact@rvo.nl

www.rvo.nl

The study was commissioned by the Ministry of Agriculture Nature and Food Quality

© Netherlands Enterprise Agency | Juli 2021