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Towards ASN Bank's Biodiversity footprint

A pilot project

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Summary

Objective and footprint methodology

The report describes a pilot project that focuses on establishing insight in the biodiversity impacts of the investments of ASN Bank. ASN Bank wants to develop this insight in order to determine what long term objective on biodiversity the bank could formulate and what policies it could implement to achieve this objective, in analogy with its climate policy.

A challenge in this respect is the fact that whereas there is consensus about the indicator to be used in climate policy (CO_2-equivalants), there is no sicu consensus on the metric that expresses biodivestity impact, and it is even not completely clear if such a metric can quantify all cause effect relationship between the bank's investments and biodiversity. For this reason, this report describes impacts both in a quantitative way and a qualitative way, where the qualitative analysis aims to highlight and address the limitations of the quantitative methodology and provides a knowledge base for interpretation of the quantitative results.

The quantitative methodlogy is derived from the LifeCycle Analysis approach (LCA). This approach consists of two parts:

- The inventory stage; here the investments are fed into a database resulting in a list of emissions, resource use and land use. The database used in this pilot is the Exiobase input/output model; This database describes 90% of the global economic activity in a model that registers 170 sectors in 43 countries and 5 larger regions. All economic flows between all sectors and all regions are quantified, and for each sector the relevant emissions have been collected. All investments of ASN Bank are linked to one of these sectors in the country where the activity takes place.
- The impact assessment phase. The emissions, resource use and land use are fed in the so called ReCiPe method, which has cause-effect mechanisms for a number of environmental aspects, linking envrionmental impacts to impacts on biodiversity. This includes climate change, land-use, water stress, eutrophication, acidification and toxicity. The result is a parameter that expresses the fraction of species lost in a certain area during a certain time; this loss of species is used as a proxy to indicate the ecosystem quality or health.

The qualitative analysis describes the (potential) biodiversity impacts resulting from the bank's invetsments in a much broader scope than the ReCiPe method can do and it suggests way yo deal with the limitations of the quantitative approach.

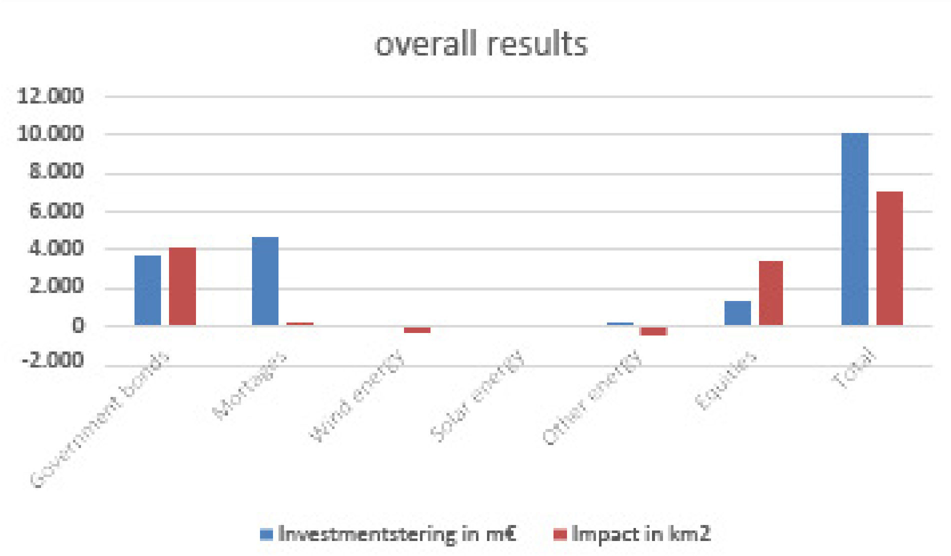
Results of the footprint analysis

The results are presented for each investment category and includes a quantitative as well as qualitative assessment. When the results of the quantitative results are combined, the resulting impact on biodiversity of all of ASN Bank's investments can be expressed as an area of about 7,000 km^2 in which all biodiversity is lost. It should be noted that area size and the percentage of biodiversity loss are linked in this expression of impact: the result can also be expressed as an area of 70,000 km^2 in which only 10% of biodiversity is lost. An area of 7,000 km^2 more or less equals the size of the provinces of Noord- and Zuid Holland combined (6,382 km^2).

It should be stressed that the data and methods only provide an indication of the order of magnitude of the impact. There are many uncertainits in the data and the methodologies used and not all investements could be included in the analysis, including some investements with a potentially positive impact on biodiversity, like investements in water boards. Moreover, the impact calculated is probably a 'worst case impact' since ASN Bank has already implemented a biodiversity policy through which some of the impacts are already addressed. The value of the footprint anlysis is therefore not so much in the exact impact calculated, but in the insights in the relative contribution of diferent investments (what are biodiversity impact 'hot spots'?) and the reasons why (what drivers are the main cause of this loss of biodiversity?).

The results can also be presented in a graph showing investmets and calculated biodiversity loss (calculated as km^2 with 100% loss).

The graph clearly indicates that the impact per Euro differs per investment category. In the case of energy generation the impacts are even negative, resulting from the replacement of fossil energy by non-fossil energy sources.



The results were used to see whether a 'no-net-loss' of biodiversity strategy might be feasible, similar to the bank's carbon neutral strategy. In this experiment we used a less conservative way of calculating the benefits of fossil free energy and checked what would happen if the investment in such technologies would increase with a factor 5 at the expense of investments in equities (which showed a relatively high impact on biodiversity). This thought experiment (!) shows that reaching a no-net-loss is indeed feasible.

Methodological discussion

On the one hand, the methodology used in this research is too simplistic, as it cannot capture all drivers of biodiversity loss that are discussed in the qualitative assessment. On the other hand, the shere volume of the report already shows that the method is quite complex. One way to simplify would be to focus on the three most important cause-effect chains (Climate change, Land use and Water stress) and ignore the other cause-effect relations which, at least in this pilot, do not play a significant role.

While the qualitative analysis is quite valuable as a reality check, it is not yet clear whether the qualitative analysis should be used to change the scores of the quantitative analysis and if so, how? For instance, current calculations of the impact of ASN bank's investments are based on average sector data. However, since ASN Bank's investment criteria on biodiversity are already quite strict, companies that ASN Bank invests in will probably perform much better than the average in the sector. How this (qualitative) knowledge can be integrated in footprint calculations is not yet clear.

Overall it can be concluded that the pilot study provides very good insights in the biodievsrity mpact hot sports and related causes. The results provide valauable input into a 'biodiversity dashboard' showing what steps ASN Bank can take to address its biodiversity impacts. This includes both parallel and consecutive steps focusing on the bank's investment policy, the footprint methodology and the involvement of exprts and other stakeholders in the process.

Whether or not a no not less strategy is the long term objective the bank is looking for is up to the bank to decide. Regardless of this decision, the bank is eager to share the results of this pilot project to inspire other financial institutions to collaboratiovely work on this topic.

Abbreviations

LCA	Life Cycle Assessment
ReCiPe	Impact assessment methodology widely used in LCA to calculate (for example) the impact on biodiversity from pressures (so called mid point indicators) like climate change and land use, see www.lcia-recipe.net
PDF	Pontentially disappeared fraction (of species) used in ReCiPe
m^2	Square meter.
Yr	Year
ha	Hectares (10.000 m^2)
km^2	Square kilometer
ha – km^2	1 ha = 0,01 km^2
CO_2 eq	Carbon dioxide equivalents, indicating the radiative forcing during the next 100 years of all gasses that contribute to climate change, expressed in Carbon dioxide equivalents
GHG	Greenhouse gasses
FSC	Forest Stewardship Council
PEFC	Programme for the Endorsement of Forest Certification
HCVA	High Conservation value Area
HCVF	High Conservation Value Forest
IBAT	The Integrated Biodiversity Assessment Tool (IBAT) provides information on biodiversity priority sites (fee based)
GMO	Genetically Modified Organisms
NACE code	Nomenclature of Economic Activities; the European statistical classification of economic activities
AAF	ASN Duurzaam Aandelenfonds
MWF	ASN Milieu & Waterfonds
SMF	ASN Duurzaam Small & Midcapfonds
Mix	ASN Duurzaam Mixfonds
EFO	Energiefonds Overijssel

1 Introduction

1.1 Objective of the project

ASN Bank (and other banks) would like to understand what impacts the bank's investments have on biodiversity: the biodiversity footprint of the investment portfolio. ASN Bank and other banks can use the information from such a footprint analysis to assess what steps are needed to minimize these impacts, to reach a no-net-loss situation or a situation of a net-positive-contribution.

In this report, a (draft) methodology is presented to assess the biodiversity footprint of an investment portfolio. A point of departure for this apporach is the fact that most banks will probably not be interested in a complex assessment, requiring a high input of time and budget. The approach should therefore be pragmatic, but reliable and transparent at the same time, allowing for a discussion with stakeholders and use by different financial institutions. The methodology presented in this report was developed in close cooperation with ASN Bank and was tested by assessing the footprint of ASN Bank's investment portfolio.

We would like to emphasise that this is a draft method, which has been used to produce quantitative information that, as such, is not sufficiently reliable to be used for external communication or to base investment decisions on. To use the results, they need to be interpreted taking into account the limitations of the methodology and the results of the qualitative analysis.

1.2 Approach

A stepwise approach was used to develop the methodology and calculate the footprint of ASN bank's investment portfolio:

1. Development of a draft methodology, both quantitative and qualitative
2. Testing of the draft methodology based on a selection of investments from ASN Bank's investment portfolio
3. Alignment of the methodology and assumptions with ASN Bank's climate footprint methodology
4. Fine-tuning of the methodology based on the results
5. Calculation of ASN Bank's biodiversity footprint
6. Stakeholder discussion

The resulting methodology to determine the biodiversity footprint of an investment portfolio includes:

1 A quantitative approach, based on Life Cycle Assessment data, the ReCiPe methodology and Exiobase as a way to take into account trade flows between countries.

2 A qualitative analysis that complements the LCA analysis, e.g. by looking at issues not covered by the quantitative approach.

ASN Bank's footprint

The methodoloy was tested by assessing the biodiversity footprint of ASN Bank's investment portfolio, including an interpretation of the results and the identification of action perspectives. In calculating the footprint of ASN Bank, a selection was made of investments covering around 90% of ASN Bank's investment portfolio.

Taking into account the limitations of the methodology, the results of the quantitative and qualitative analysis were used to determine:

- The biodiversity impact hotspots within ASN Bank's investment portfolio
- The reasons behind the footprint results (explanation of impact calculations)
- What the results could mean from a policy and investment point of view (the action perspective)

1.3 Reader

The Biodiversity footprint methodology is presented in the chapters 2 and 3. Chapter 2 discusses the quantitative footprint calculation based on the ReCiPe methodology. Chapter 3 discusses the (potential) limitations of the quantitative analysis and shows how a qualitative analysis can complement the quantitative footprint analysis.

In chapter 4 the results of the footprint analysis for ASN Bank is presented, covering both the quantitative analysis and the quanlitative analysis and the interpretation of the results.

In chapter 5 the conclusions and recommendations are presented.

2 Biodiversity footprint methodology: quantitative analysis

2.1 Introduction

Assessing biodiversity is far form a trivial thing, even when you are in a specific location and have time to study an area. One of the challenges is that there are many levels at which you can describe biodiversity:

- The species abundancy
- The gene pool, the variety of genes, and with that the robustness of the system
- The habitat
- The functional value of the ecosystem (what is the economic value it generates)
- Etc.

Species abundancy has been used quite often as an indicator and the damage to diversity can then be described as the fraction of species that has been lost in comparison with a natural or undisturbed area. This measure also has its problem, as sometimes the species numbers increase while we may not agree that these are desired species. For instance, we were using a model produced by RIVM to assess the impact of acidification on the fraction of species lost.
That model showed that even without any acidification, the damage in the biggest natural area in the Netherlands (de Veluwe) is huge. This is because in the nineteenth century trees were planted, and these give shadow. Many species that were supposed to be in an open landscape had disappeared because of the tree. This means that models often make use of so called target species, and refer to a target habitat. The habitat in the Veluwe was supposed to be an open sand-dune landscape in that model.
Understanding the biodiversity impacts on a local scale is one thing, but understanding the biodiversity impacts on a global scale from investments adds a layer of complexity. This requires an understanding of how investments influence economic activities, and from there how such changes disturb habitats and cause a loss (or gain) in species numbers.

2.2 Biodiversity assessment in LCA

The LCA method has been designed to model biodiversity impacts caused by the production of products, and for this methodology we base ourselves mostly on the LCA method. Do not be surprised as in the rest of this explanation the uncertainties in the assessment are large and sometimes huge.

LCA has two parts:

1. The inventory of all emissions and resource use, this includes the use of land and water resources
2. The lifecycle impact assessment (LCIA) stage; the understanding of how these emissions and resource uses translate to meaningful indicators that describe a societal problem

2.2.1 The inventory stage

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:

1. 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.
2. The input output approach. In these databases, we do not describe a specific industrial operation but we take the average of the activities in an economic sector, and we specify the inputs and outputs in monetary terms. So in the same example: to produce one euro worth of steel, you need to purchase x dollar form the fossil fuel sector, and y dollar from the ore sector, while you produce y kg of CO_2.

In the ASN Bank methodology, we use Exiobase as the input output database. More information can be found on www.exiobase.eu.

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Both types of data has their advantages and disadvantages: traditional data can be more specific. You do not need to work with the average impacts of the fossil fuel sector; instead you can use data that accurately specifies the impact of a specific supplier. 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 hundred, and sometimes thousand emissions and resource uses.

2.2.2 The impact assessment stage

Once we have a list of resources and emissions, we need tounderstand their meaning. Over the years many researchers developed methodologies that translate all these emissions in 10 to 20 so called impact categories, such a climate change, ozone layer depletion etc. Interpreting such a list of impact categories is not too easy, and that is why some of these methods have been further reduced to specify the results at a higher aggregation level. Since 1995, PRé has been a strong promotor of this idea, and has been responsible for the development of several methods, such as Eco-indicator 95, Eco indicator 99 and ReCiPe 2008. ReCiPe was a joint project with RIVM, Radboud University and Leiden University; it was funded by the Dutch Government. It is available for free at www.lcia-recipe.net.
A key characteristic of the latter method is that it translates 18 impact categories into three so called endpoints: Human Health, Ecosystems and Resources. For this project we have ignored the impacts on human health and resources.

2.3 LCIA, or from emissions and resource use to biodiversity impacts

The figure below provides an overview of how the emissions and resource use produced by Exiobase and other databases are linked to no less than ten impact categories and how nine[1] of them are linked to biodiversity impacts, expressed as species.yr. In the original ReCiPe method, we could not link the impacts of water use, but other researches have filled in this gap and developed a water method that is compatible with ReCiPe. We use the version of Pfister.

For a description of how all these impacts influence biodiversity we refer to the ReCiPe report and the underlying peer reviewed scientific articles, but we can focus on the three impacts (Land-use, Water Scarcity and Climate change) that have by far the most significant impact in the ASN Bank project.

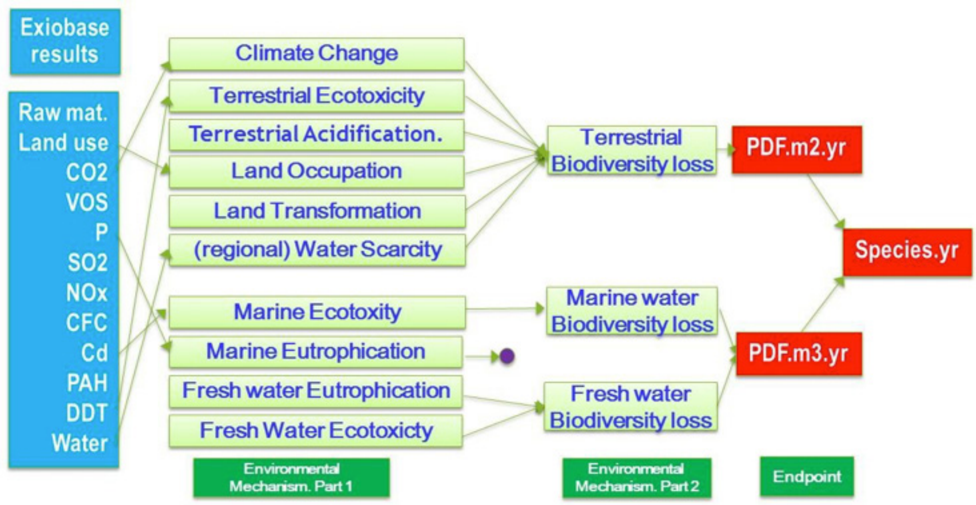


Figure 2.1: Schematic overview of the environmental mechanisms in the ReCiPe method. PDF refers to Potentially Dissapeared Fraction of species; the percentage of species being lost in an area or volume during a certain period.

When we talk about species in ReCipe, 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.

In the next three sections, the three main pressure factors on biodiversity, climate change, land- use and water stress are discussed.

[1] It was not feasible to link Marine Eutrophication, although we do not expect this to have a significant influence. Similarly impacts of climate change on water could not be modelled. We also expect ozonelayer depletion has some impacts on Marine Eutrophication.

2.3.1 Climate change and biodiversity

As an illustration, we will describe how the link between climate change and biodiversity is made, in a number of steps that describe the cause effect mechanism. The specific problem is that, although we know the impact of the historic emissions on the climate, we would like to know the impact of adding or avoiding an additional kilogram of emission.

From CO_2 equivalent to temperature increase

A researcher (Meinshousen) has compared the so called climate sensitivity of the current climate models, and came up with the figure below. He studied the impact of avoiding CO_2 emissions. There are two lines; the lower describes the immediate response of such a reduction, the higher shows the impact of the equilibrium that is reached many years after the emissions have been avoided.

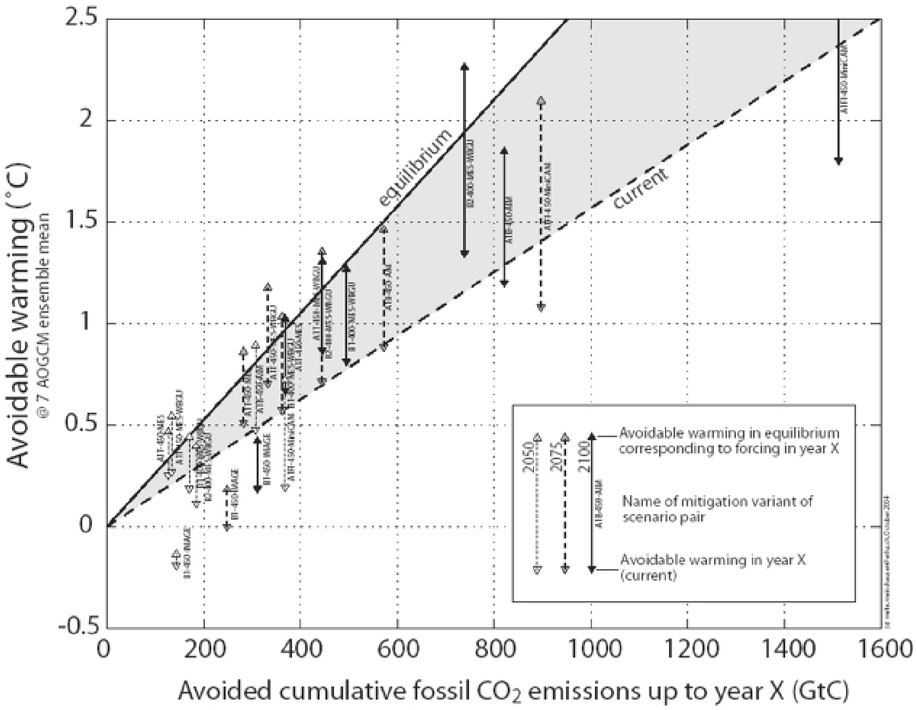


Figure 2.2: Meta analysis representing how a large number of climate models link a change on CO_2 emissions to a change in temperature. In this case the analysis is made for determining the impacts of a successful climate mitigation policy. The current line represents the immediate effect of a reduction, the equilibrium line represents the longer term effect. (Source: Meinshausen)

We interpret this graph that every 1000 Gigaton has an effect of 2.6 degrees at equilibrium, or in other words, every kilogram has an effect on temperature of 65e-15 C.yr or written in full 0.000000000000065 degrees during one year.

The addition of a time dimension requires some attention. One kg does not have an impact forever, after about 150 years, the CO_2, will be gone from the atmosphere, so one kg can only give a temporary effect. We will see this is also the case for land use: producing a kg of a crop only requires an area during a year.

From temperature to biodiversity impacts.

For this step we used a publication in Nature (see Thomas et al.) that analysed a large number of studies that link temperature increase to loss of species. From this, we could establish relationships, as are illustrated below, in the case of butterflies. On the horizontal line we see the temperature increase, on the vertical axis, we see the percentage of species that will disappear due to the temperature increase.

The analysis is made under two assumptions: one assumption is that the butterflies have enough time to migrate with the change in temperature (the lower line; the higher line takes the assumptions that the butterflies cannot do so; this causes a higher predicted damage).

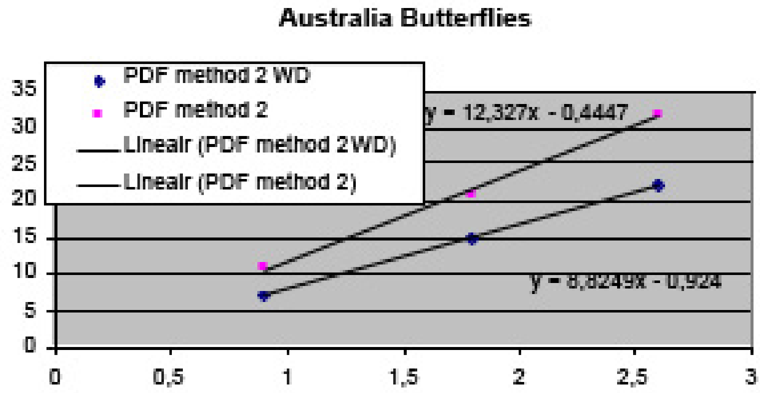


Figure 2.3: Several scientific publications link an increased temperature to a loss of species; in this case the example of Australian butterflies is used. The lower line represents the assumption that the butterflies can move to regions with good climate conditions; the higher curve represents the situation that species cannot find such a region, either because the region is not there, or the speed of climate change is too high. (Source: Thomas et.al. 2004)

We have used this type of data from several studies especially focussing on vascular plants and insects, as the impacts on higher species are more difficult to determine. If something goes wrong at the start of the food chain, most experts assume that this will determine much of the fate of the higher organisms, as also discussed earlier.

Please note that we had calculated a temporary change of the temperature; this also implies that emitting a kilogram of CO_2, has only a temporary impact on the species richness. This basically means that this model assumes that when the emissions stop and the temperature decreases, the species may return. This also means we treat all species equal, and cannot distinguish between red list or endangered species and other species. However, if the emission flow is constant or increasing over many years, the temperature increase will also stay high, and the loss of species is permanent, as long as the emission flows last.

If 10% of the species are lost from an area on 1 hectare this indicates that hectare loses 10 % of its biodiversity. This damage is the same as an area of 10 hectares that loses 1% of its species; at least this is how the ReCiPe method has been set up. We can also say that if this 10% loss of species lasts one year on that hectare, this is equivalent with losing 1% over ten years. This means PDF, time and area size are interchangeable in ReCiPe. This was necessary as some impacts last quite long and spread out over a vast area (like climate change) while others have a local effect, during a relatively short time.

The damage to diversity can thus be expressed in terms of PDF.m^2.yr, which can be read as the potentially disappeared fraction of species that disappears in a certain area during a certain time.

2.3.2 Land use

With Land-use we refer to two forms of land-use:

1. The occupation of an area during a certain time.
2. The transformation of an area from, let's say from forest to agriculture. This is also referred to as 'land-use change'.

In LCA we keep this separate, as we think a farmer that uses its land year after year, should not be held responsible for its predecessor that has once converted the land. This is somewhat different to the rules in the GHG protocol where a farmer is charged, in any year if the transformation has occurred in the last 20 years. So in LCA, the responsible actor for converting the land is charged with the conversion and the (sometimes very long) restoration time.

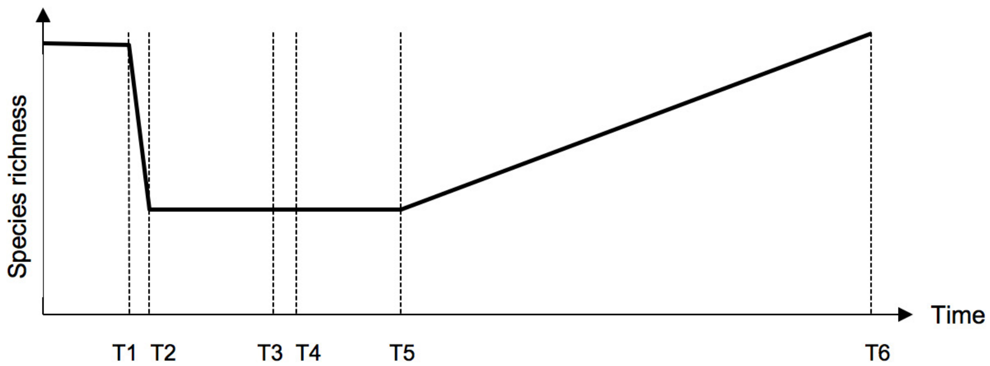


Figure 2.4: The bathtub curve shows the relationship between species richness and time, after a conversion of a natural area occurs between Time 1 and 2, and that an area remains occupied till time 5, after which it recovers slowly to a natural state.

In the figure above we plot the species richness over time when an actor converts a piece of nature. Between time 1 and time 2, there is a rapid decrease. After that we assume there is a stable situation and there are no further changes in the species richness. We assume that at some point in time, the occupation stops and a restoration takes place between time 5 and 6. Whether a natural system can restore to the original species richness is unclear, and when this will happen is also unclear. However, we find it reasonable to assume that we need to compare the current impact with a situation where no impact takes place.

If we look at the impact of a farmer that uses the already converted land between time 3 and time 4, we cannot hold him accountable for the conversion. However, as long as the farmer uses the land, it cannot restore to nature. So the impact allocated to the farmer can be calculated by multiplying the loss of species with the duration of the occupation and of course the area size. Again, we get PDF.m^2.yr as a unit.

The actor that has converted the land is responsible for the damage between time 1 and 2, as well as the damage done between time 5 and time 6, the restoration time. As the conversion time is usually much shorter than the restoration time we tend to ignore the first period.

The conversion has the unit of m^2, and we multiply the converted area with the restoration time, and in this case with half the PDF, as during the restoration period the species richness slowly recovers. As restoration times to restore nature typically are assumed to take around 100 years (ReCiPe 2008, Goedkoop et al., 2009), converting a square meter has an about 50 times higher impact than occupying an area during a year. It is important to get a clear view to which extent a company can be held responsible for converting land, and to which extent it has taken care that it only uses land that has been converted before.

While it seems convenient to talk about the natural state, it is in fact not so easy to describe what that is. The figure below provides a biodiversity map of the world, and shows large differences in the number of plant species. In ReCiPe we decided that the absolute number of species is not so important as the relative number, so the 20 to 200 vascular plant species that can be found in the Sahara together form the ecosystem, and halving that number of species is seen as being equally important as halving the species number in the Peru, where there can be more than 5,000 species. This implies that loosing one species in the Sahara has a much bigger impact than loosing one species in Peru.

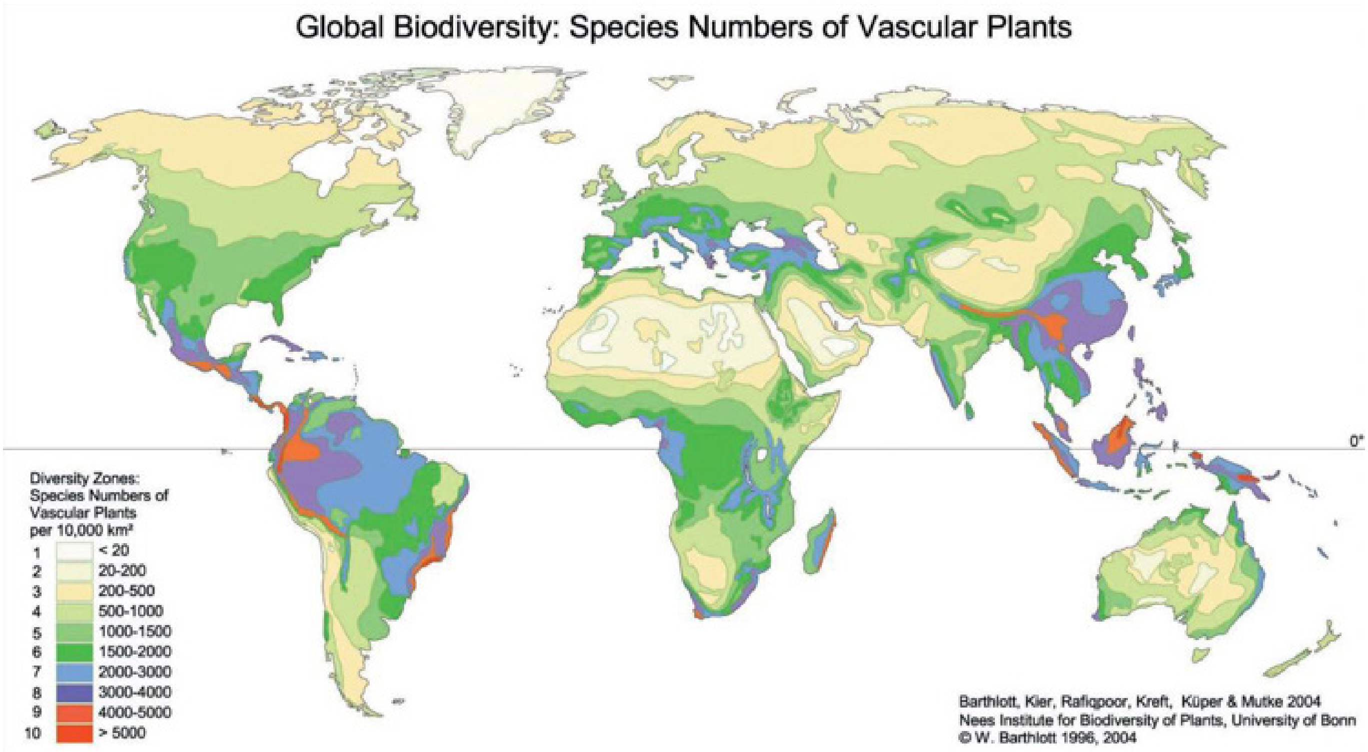


Figure 2.5: The biodiversity varies greatly over the planet.

The next question is how we know the species numbers on agricultural and urban land. For agriculture the answer seems easy, as a farmer only wants one species on the land. However, agricultural farmlands are in fact quite rich in species, and that is because there is a rich diversity in the edges, small unused plots, and pathways. We used a very detailed inventory made in the UK (Countryside survey) where experts had counted species on the land itself (the X-plot); the area just inside the fence (A-plot) and the area just outside (the B-plot). This inventory shows that the species richness is not really determined by the crop itself, but the presence of edges, hedges, and small bushes or rows of trees. So a large scale monoculture, or a small scale traditional landscape makes all the difference. Unfortunately that aspect is usually not reported in LCA, and we had to take an average species loss of around 40% compared to the reference. To what extend this has a global validity is unclear, but we would be surprised if that number is completely wrong in other parts of the world, except where there are huge monocultures.

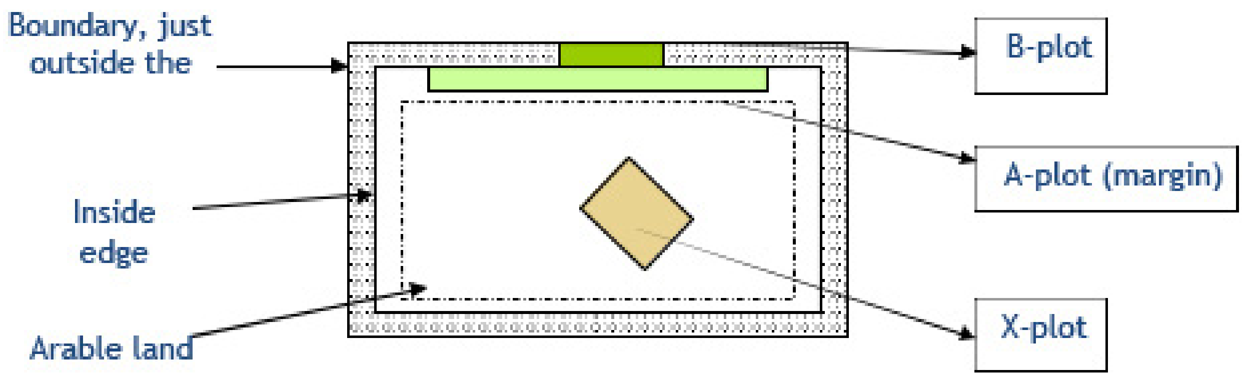


Figure 2.6: Simplified model of an agricultural area: the diversity on the areable land is generally very low (as that is the objective of the farmer). The biodiversity is therefore highly determined by the edges of the land; the small strip just inside the border, and the strip outside the border. (Source: country side survey 2000)

2.3.3 Distinguising between different types of land-use

In the ReCiPe method we calculated different factors that reflect the intensity of the land use, as is shown in the table below. Unfortunately, in the Exiobase dataset such a difference is not made, which can cause some distortions we will discuss later in this report. If we would be able to further specify the intensity, or the extensiveness of agricultural processes, we could gain precision.

The table below provides the main characterization factors for the occupation of various types of agricultural and urban land. Without explaining the complex backgrounds, please note that we distinguish between a damage that is caused on the agricultural land itself (local effect) and a regional effect. The regional effect is caused by the generally accepted finding that a smaller natural system will have a lower diversity, even if that natural area is untouched. The regional effect is a constant factor, as this is related to a characteristic of the natural area and not influenced by the type of land-use. The total effect is the sum of both effects. It may seem counter intuitive that occupying one m2 has an effect on an area that is larger than a m2, but this is caused by the regional impact. Example: if an area is asphaltated, the species diversity becomes zero in this area and thus the PDF becomes 1 (100% species loss). This may seem like the maximum damage possible, but it is not. Covering this area with asphalt also means that the remaining area (regional effect) becomes smaller, and a smaller region has fewer species. This means that the impact exceeds the asphaltated area. If we calculate this in terms of PDF.m^2.yr we get this high score (the affected area is larger than the area asphaltated).

The table also shows that what is called "broad leaved forest" has no impact; we have used this as the reference.

Land use type	*Local effect PDF.m^2.yr*	*Regional effect PDF.m^2.yr*	*Total effect PDF.m^2.yr*
Monoculture Crops/Weeds[1]	0.95	0.44	1.39
Intensive Crops/Weeds[1]	0.89	0.44	1.33
Extensive Crops/Weeds[1]	0.85	0.44	1.29
Monoculture Fertile Grassland[1]	0.69	0.44	1.13
Intensive Fertile Grassland[1]	0.48	0.44	0.92
Extensive Fertile Grassland[1]	0.25	0.44	0.69
Monoculture Infertile Grassland[1]	0.41	0.44	0.85
Extensive Infertile Grassland[1]	0.00	0.44	0.44
Monoculture Tall Grassland/Herb[1]	0.92	0.44	1.36
Intensive Tall Grassland/Herb[1]	0.61	0.44	1.05
Extensive Tall Grassland/Herb[1]	0.31	0.44	0.75
Monoculture Broadleaf, mixed forest and woodland[1]	0.19	0.44	0.63
Extensive Broadleaf, mixed and yew LOW woodland[1],*	0.00	0.00	0.00
Broad-leafed plantation[2]	0.37	0.44	0.81
Coniferous plantations[2]	0.47	0.44	0.91
Mixed plantations[2]	0.76	0.44	1.10
Continuous urban[2]	0.96	0.44	1.4
Vineyards[2]	0.42	0.44	0.86

Table 2.1: summary overview of the impact of certain types of land use (occupation), expressed as Potentially Dissapeared fraction of Species on a certain area, during a certain period. (Source: Goedkoop et al.)

In the case of urban land-use the issue is somewhat more complicated. Suburbs have a lot of green areas, and gardens contain a wide variety of plants, but these are not the naturally occurring plants, and they are not counted. The UK study, and a Swiss study we used, counts the species that are naturally occurring in area's outside the gardens, like road edges, bushes etc. This shows that there is a relatively small difference between average urban areas and agricultural systems.

2.4 Water scarcity

Originally water was not modelled as a factor that contributes to species loss. The method of Pfister (Pfister et.al) has been used to add this, as Pfister has developed this method to be in line with ReCiPe. This method does not simply count the green, blue and grey water, but it really assesses water scarcity, and its impact. This is in line with the ISO waterfootprint standard that clearly states that just calculating the amount of water used is not a proper metric.

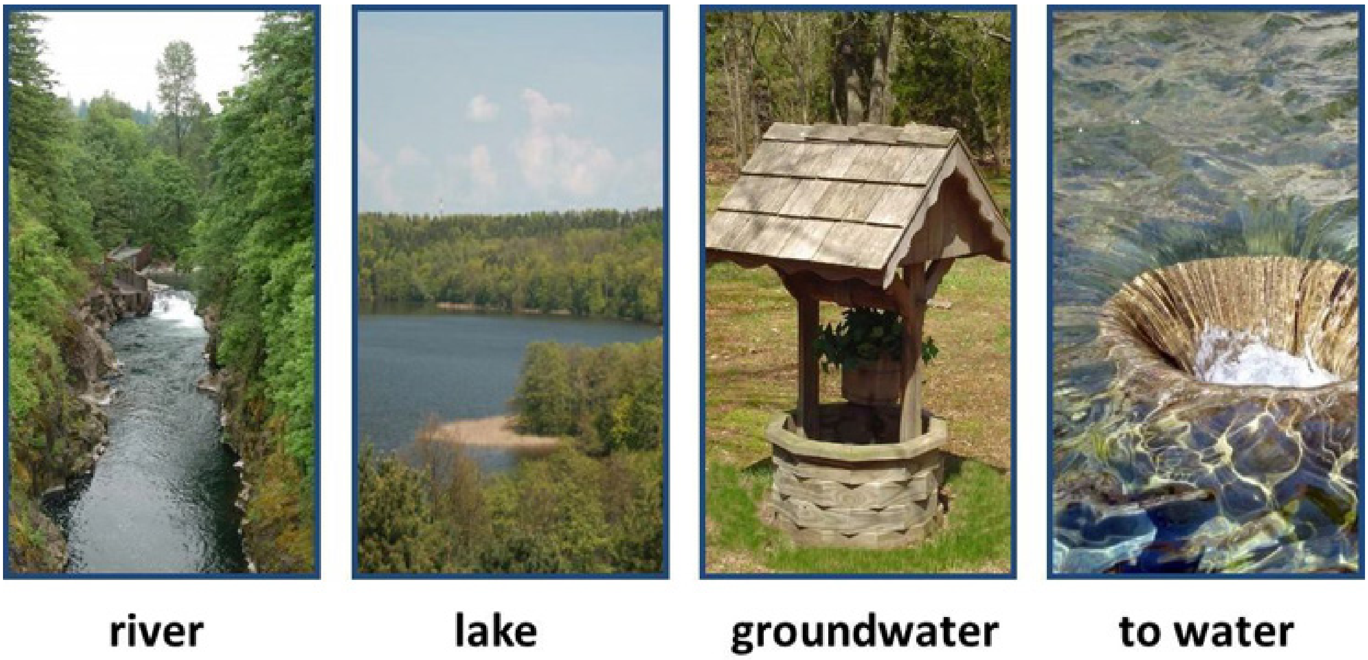


Figure 2.7: The three type of water use, and the return to water to the natural systems are modelled, creating the possibility to establiche a water balance.

The databases used for this project reports three types of water extraction, and one flow of water being returned to nature. In this way we can understand the water balance. The data are specified per country, and that information is mapped on a global water stress model. The link between water stress and species lost was then added to come to a unit expressed as PDF.m^2.year. For this Pfister uses detailed global maps, largely based on (http://www.worldwater.org/data.html) which include data that indicate the loss of species due to water scarcity. These local data are then averaged per country, to get a water scarcity impact factor per country.

2.5 From PDF to Species

An issue not yet discussed here is that some impact categories have an impact on the number of species in water, and for water we cannot talk about species per square meter, but instead we have to use species per cubic meter. In ReCiPe we have developed a conversion factor to bring these two units under one common unit. The trick we used is the divide the results for land and water by the species density on land per square meter, and the average species density in water per cubic meter. If we do this we get a unit expressed as species.year.

For the ASN Bank project this unit is less convenient, as ASN Bank wants to understand the area it needs to compensate, so the PDF.m2.yr is a much more convenient measure. If we get a result of 3 PDF.m2.yr, it can be interpreted as:

- 3 m^2 has lost all its species during a year
- 30 m^2 has lost 10% of its species during a year
- 3 m^2 has lost 10% of its species during 10 years.

This means we only know the combined effect, but in principle we can use the first interpretation to calculate the footprint; the area lost all of its species during a year.

In our calculations we used the conversions to species.year to convert the damage to water bodies into a unit for land based systems, so in fact we do not use the species.year.

2.6 Notes on the Exiobase database

The Exiobase[2] database is very new and has impressive specifications. There are a few points that need to be understood as they determine some of the outcomes, and also cause some problems in the understanding of the results.

Exiobase works with a standard model of the economy; it covers 43 countries, that together represent 90% of the World's economy and 5 "rest of the World" regions that cover the remaining 10% of the economy. It has collected data for all 48 regions on economic activities, environmental and some social aspects. For this, it distinguishes 163 industrial and service sectors. All tradeflows between all these sectors are also specified, which leads to millions of tradeflows. There are also some special categories, like the activities caused by the total consumption in a country and the impacts of government expenditure and purchases. See Figure 2.8.

Since for each sector, the main environmental impacts were collected, if one knows in which sector and country a bank invests, it is possible to understand the impacts of this investment in that sector, but also the impacts in the supply chain that is used by that sector.

All this is may sound impressive, but there are a few things to observe:

- Dividing an economy in 143 sectors provides a rather coarse classification of economic activities. So if an investment is made in a specific industrial activity, it is not always clear to which sector it belongs. For instance, Nike makes apparel, but is also big in retailing, which is another sector. The other problem is that a sector that produces apparel is a very broad sector, it produces both cheap T-shirts as well as expensive shoes. All impacts per Euro are however the same in a certain sector, so in fact the price determines the impact, and not the specific materials used or the way it is produced.
- One should wonder how all this data is gathered, as every country has its own way of defining sectors, and collects its data according to that sector classification. For instance, Germany uses a classicification of just over 40 sectors, while the US and Japan use about 500 sectors and the Netherlands use just over 130. For Exiobase, all that information had to be re-allocated to fit the framework of 143 sectors; this can of course create distortions.
- A particular problem are the Rest of the World regions, as often very little data is available.

The way the environmental data has been defined has also a number of issues. In the version we have to our disposal, only one type of land occupation is specified and we have interpreted this to be agricultural land. Land conversion is not modelled as such, but land conversion has been 'converted' into land occupation, using an approach that is not crystal clear to us. In the latest version of Exiobase (we use version 2, but version 3 is recently made aviailable), more details on land-use are available. According to the specifications 15 land-use types will be available. This will be a great improvement.

Because of these limitations we have seen a number of strange results. For instance, the investments in state bonds are dominated by the import of coffee out of the Rest of the World regions, mainly Africa, while the expenditure on that supply is relatively low (less than a percent). This would imply that the impacts from government workers drinking coffee has a very significant impact, which is at least counter intuitive.

We think this can be explained by the lack of detail in the land-use type. In a 1999 study we made together with RIVM, where we calculated the impacts of the average Dutch consumer, we encountered the same issue. Statistical information sees the use of very extensive farming activities like hunting and gathering coffee beans from a forest as a complete occupation of a forested area, while in fact the forest is not damaged in any significant way. At the time of the study we could not find data that gave a more realistic impact, and we think the makers of Exiobase had the same problem.

[2] See www.exiobase.eu for all information.

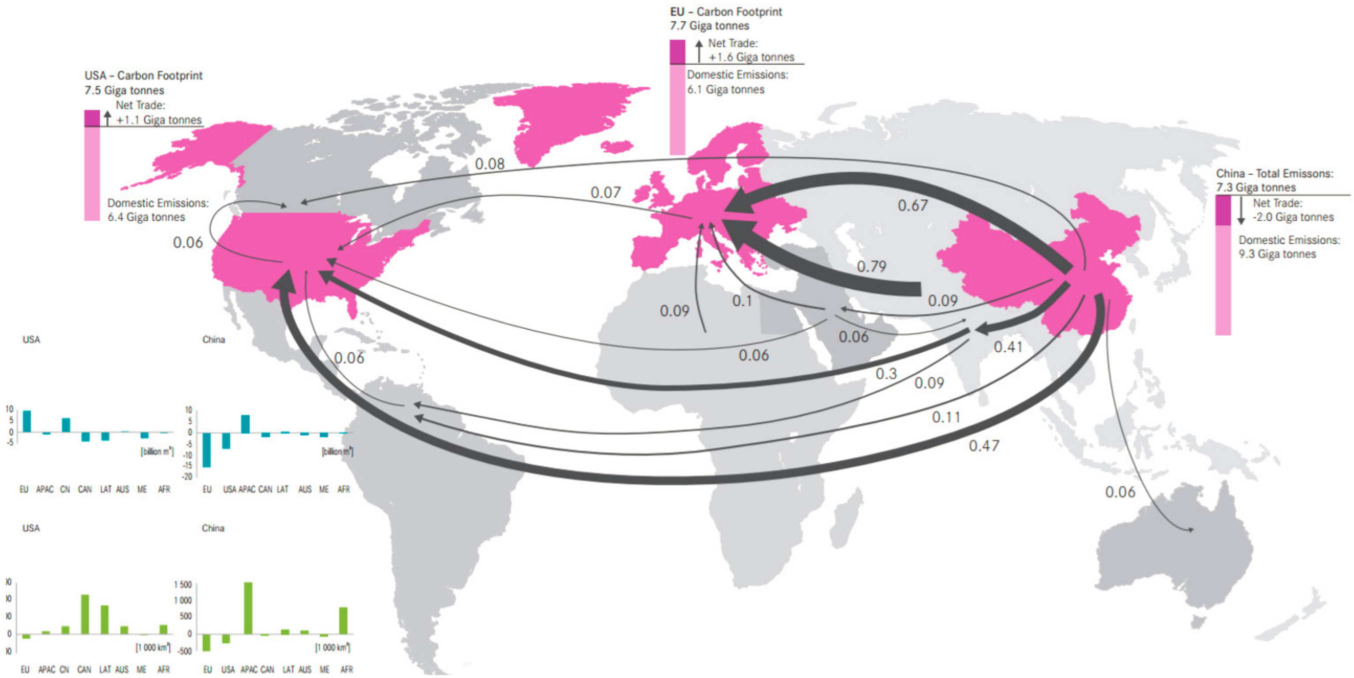


Figure 2.8: Illustration of one of the many applications of the Exiobase data. As all the tradeflows between all sectors in 43 economies and 5 rest of the world regios are known, it is possible to calculate the embodied CO_2 equivalents of all the exports of a country, in this case China. For this project we use these relationships to see how much embodied impacts are in the purchases of a company in a certain sector in a country. (source: CREEA booklet)

2.7 Some notes about the ecoinvent database

The ecoinvent[3] database is widely accepted in the LCA community, as it provides a very transparent view on the World, and it is very well documented. When ReCiPe was developed we took the way ecoinvent specifies emissions and land-use as the starting point, and as such the link between data and method is very good. Ecoinvent also specifies land conversion and has information for agricultural practices in various places in the World, but that coverage is far less extensive compared to Exiobase.

The main limitation of ecoinvent in this project is that it is developed to assess products, and not economic activities, in which a bank invests. All data are specified in terms of mass, volume and other physical parameters but not in monetary units. This means the investment portfolio has to be translated in terms of mass and other non monetary units. For a wind-park this is not a big problem, although it causes some work, but if we take the example of Nike, we have a problem when modelling the retailing activities, as these are not about mass flows, but service flows, and services are the largest share of todays major economies. Here Exiobase does a much better job.

2.8 Some conclusions regarding the validity of the quantitative assessment

As noted at the start of this chapter; assessing the impacts of all economic activities mankind performs on all aspects of biodiversity in quantitative terms is far from a trivial exercise, and some will maintain it is in fact impossible.
The descriptions of the ReCiPe methodology sheds some light on the way the scientific model from an emission or land use parameter to the species indicator works and what the issues are. As we have noted there are a number of limitations that need to be addressed in a quantitative analysis in the next chapter.

From the onset we have used Exiobase as the main datasource, but our conclusion is that this choice hase some fundamental problems. For instance, the strange effect we have seen when assessing the statebonds makes us feel uncomfortable about the validity of the results. We think that for now the results of this investment category should not be considered to be vailid. In chapter 5 we have developed some thoughts to address this while at the same time simplifying the method.

3 See www.ecoinvent.org

3 Biodiversity footprint methodology: qualitative analysis

3.1 Introduction

The objective of the qualitative analysis is to assess to what extent the quantitative analysis covers all biodiversity impacts that may be relevant and significant for a specific investment.

The analysis consists of two parts:

- An identification of the *general limitations* of the quantitative analysis, relevant to all sectors/investments,
- A *sector-specific* qualitative analysis focusing on sector specific issues regarding biodiversity impacts which may not be (fully) covered by the quantitative analysis.

The results of the qualitative analysis will either show that:

- there is **no reason** to assume that the impact on biodiversity will be (very) different from the impact score and related drivers resulting from the quantitative analysis;
- there are reasons to assume that the impact on biodiversity (in a specific location) may be **higher** than the quantitative analysis reflects;
- there are reasons to assume that the impact on biodiversity (in a specific location) may be **lower** than the quantitative analysis reflects.

These results of the qualitative analysis can be used to:

1. Adjust the score from the quantitative analysis (increase or reduction).
2. Take into account the reasons for a potentially *higher* impact score by means of investement criteria addressing these reasons, thereby reducing the chances that the score (at a specific location) will indeed be higher; in this case an adjustment of the ReCiPe score is not needed.
3. Take into account the reasons for a potentially *lower* impact score by means of investement criteria addressing these reasons, thereby increasing the chances that the score (at a specific location) will indeed be lower. In this case an adjustment of the ReCiPe score would be needed.

This means that the qualitative analysis not only focuses on the assessment of the footprint (could it be higher or lower than the quantitative analysis shows?), but also on the action perspective resulting from the qualitative analysis (what to do with this result in practice?).

N.B.

1. It should be realised that when a financial institution decides to address specific impacts through its investement criteria (e.g. investing only in FSC or PEFC certified forestry or only in the best in class of the fashion industry) this could also result in a ReCiPe score which is too high, unless specific data of the investee are used (and the impacts do not relate to a general limitation of the ReCiPe methodology).

2. Adjusting the score from the quantitative analysis is only relevant when the results from the footprint analysis are used for communication purposes or to achieve a no-net-loss or net positive contribution situation. In that case quantitative data may be necessary. If the results of the footprint analysis are only used to assess 'impact hot-spots' and to identify action perpsectives to mitigate impacts (e.g. by means of investment cirteria), a re-interpretation of the score may be sufficient.

In the next two sections, general limitations of the quantitative analysis are addressed as well as the ways to address these limitations.

The sector specific analysis (looking at a selection of sectors ASN Bank invests in) is presented in chapter 4.

3.2 General limitations of the quantitative analysis: ReCiPe

The ReCiPe method is currently the best method available to determine the impact on biodiversity of products through a life cycle assessment (LCA). However, there are some limitations to the methodology. Limitations of ReCiPe that are valid for all investments/sectors are described below:

- **Location specific impact characteristics**
  The use of average data in ReCiPe may not always reflect the severity of local impacts resulting from local characteristics. For example, in case an economic activity (e.g. production in a factory) takes place in or close to a High Conservation Value Area (HCVA), the impacts on biodiversity may be higher than average biodiversity impacts calculated through ReCiPe. The same can be true in water scarce areas, since ReCiPe only takes into account water scarcity on a country level. Other relevant location specific factors include the proximity of Protected areas and the presence of endangered/ threatened species.

  In the qualitative analysis, the relevance/significance of these location specific characteristics to specific sectors can be addressed. For example, in case a sector is known for its high water use, it may be important to include water related investment criteria in the investment policy for this specific sector. Location specific factors like HCVAs, protected areas and the presence of endangered species can be relevant in each sector and can only be addressed by means of a general investment policy.

- **Type of biodiversity loss**
  ReCiPe provides no insight in the kind of species which are affected. Within a certain ecosystem all species are treated equally, so it can not be assessed whether red list species or very common species disappear. Stakeholders may argue that impacts on endangered species are more severe than impacts on species which are not endangered.

  This issue can only be addressed by means of investment criteria addressing (management of impacts on) endangered species.

- **Land-use related impacts**
  Land use related impacts such as land degradation, erosion, salinization, soil depletion and deforestation are not fully addressed by ReCiPe. ReCiPe is based on information from temperate developed areas and has a limited validity for other regions, like tropical regions.

  This limitation can be addressed by means of investment criteria addressing these specific land use related impacts, e.g. for sectors where these impacts are likely to be (very) relevant.

- **Impact on soil fertility/soil quality**
  Impacts on soil fertility and soil quality are not addressed by ReCiPe. This means, for example, that the positive effect of organic agriculture on soil fertility is not taken into account. The impact of pesticides is included in ReCiPe in the ecotox and human tox categories, as far as these substances leach out, evaporate or are sprayed in adjacent waterbodies. The fact that more land may be needed for organic farming will show up as a negative impact in ReCiPe. Avoiding the use of artificial fertilizer avoids much of the N2O production; this aspect is well reflected in the climate change impact category in ReCiPe. The fact that the positive effect of organic farming on soil characteristics may have a positive effect on future land use and land conversion is not taken into account.

  In case of (investments in) organic farming, this limitation may be addressed by adjusting the impact score resulting from ReCiPe. However, there is no clear correction factor for this. This means that in practice financial institutions will decide for themselves how they evaluate investments in organic farming.

- **Key drivers of biodiversity loss**
  According to the Global Biodiversity Outlook, the main drivers of biodiversity loss are (Global Biodiversity Outlook 3[4]):
  - Land use/habitat loss and degradation
  - Climate change
  - Pollution (and nutrient load)
  - Overexploitation (and unsustainable use)

[4] Secretariat of the Convention on Biological Diversity, 2010. Global Biodiversity Outlook 3. Montréal, 94 pages. https://www.cbd.int/doc/publications/gbo/gbo3-final-en.pdf

- Invasive alien species
- Disturbance of fauna and ecosystems (e.g. noise, light)

Land use/habitat loss, climate change and pollution are included in ReCiPe. However, overexploitation, invasive alien species and disturbance are not included.

In the qualitative analysis, the potential relevance/significance of the key drivers not included in ReCiPe can be assessed. A financial institution may decide to tailor its investment criteria to the results. For example, if the introduction of invasive species is a significant threat in a specific sector, the financial institution may decide to include 'management of invasive species' in its investment criteria for this sector.

- **Positive impacts on biodiversity**
  Although ReCiPe also allows for the calculation of positive impacts, certain (more specific) positive impacts on biodiversity may not become clear from ReCiPe. For example, positive impacts resulting from the creation of 'no fishing zones' around offshore windmill parks will not show up in ReCiPe. The same is true for potential positive impacts resulting from FSC certified forest management.

  In the qualitative analysis, such positive impacts can be assessed for each sector. The result may be used to either adjust the impact score resulting from ReCiPe (which will be difficult), or to take this into account in an investment policy.

N.B.: These limitations by no means disqualify the results of the quantitative analysis! It only shows that the interpretation of the results should be done with care.

3.3 Addressing general limitations by means of investment policies

3.3.1 Summary of investment policies addressing limitations of ReCiPe

The table below summarises the limitations discussed and provides suggestions on how these limitations might be addressed by a financial institution.

Issues not (fully) covered by in ReCiPe	*Investment policy options addressing the issue*	*Options ASN Bank*
Location specific impact characteristics:		
Water scarcity	• Exclusion/divestment in water-scarce areas or • Investment criterion: use of a water management system if operating in water scarce areas	Include a policy on water scarcity
Proximity of HCVA's/protected areas Presence of endangered or threatened species	• Exclusion/divestment in companies operating in or near these areas or • Investment criterion: if operating in or near these areas: - Company has a Biodiversity Management Plan or Biodiversity Action Plan in place - The area in which the investment takes place is registered as a VCA	Include a policy for areas not yet included in the exclusion policy of ASN Bank
Impact on soil fertility/soil quality		
Impacts (+ or -) on soil fertility/soil quality	• Best in class policy, e.g. Investments only in organic production	Include a policy in case of investments in agriculture

Issues not (fully) covered by in ReCiPe	*Investment policy options addressing the issue*	*Options ASN Bank*
Drivers of biodiversity loss		
Introduction of invasive species	• Investment criterion (in case of 'high risk' sectors): • Policy/management system in place to prevent the introduction of invasive species • Exclusion of/divestment in companies working with GMOs *Specific certification initiatives may be used/required to guarantee compliance*	Covered by ASN Bank policy
Overexploitation	• No use of red list species; institutions aimed at protecting endangered species are excluded from this criterion • Companies/institutions must comply with CITES legislation. • In case of 'high risk' sectors: Companies should assess a sustainable level of exploitation. *Specific certification initiatives may be used/required to guarantee compliance*	First two criteria are already covered by ASN Bank policy + third option is covered by referring to certification initiatives (like FSC)
Disturbance	• Exclusion/divestment or investment criteria in case disturbance is expected to be a serious issue (e.g. based on an environmental impact assessment) + the company is operating in or near a HCVA/protected area • Investment criterion: companies should carry out an EIA and subsequent actions in case disturbance is a serious risk and they operate in or near a HCVA	Include a policy for relevant sectors

In most cases, additional information and data will be needed to:
1. identify the relevance/significance of the general limitations of the quantitative analysis for a specific sector
2. to address these limitations through an investment policy.

A qualitative analysis can provide this information. For example, some specific positive and negative impacts of windparks, like the potential impacts on birds and bats, will only show from a qualitative analysis, not from the quantitative analysis. Addressing some of the other limitations will need access to specific data, like data on water scarce areas or the presence of high conservation value areas.

The general limitations and the need for data is briefly discussed in the following sections.

3.3.2 Data to address limitations of the quantitative analysis

Water scarcity
ReCiPe includes data on water scarcity, but only on a country scale, not on a more local scale. A source that provides insight in local water scarcity is the AQUEDUCT Water Atlas Risk of the World Resources Institute. Other examples are The Global Water Tool of the WBCSD or the Water Risk filter of WWF. Using these water scarcity tools, a financial institution can request from a client whether he is located in a water scarce area or not. Based on the result, the financial institution may either decide to divest or to require a water management system.

Presence of HCVA's, protected areas and endangered/threatened species
Impacts on biodiversity may be relatively high in or near High Conservation Value Areas (HCVAs), protected areas or in areas where red list species are present. Databases that can be used to assess the status of an area:

- The Protected Planet database provides information on protected areas in a particular location. It indicates in which IUCN category an area falls and whether sites are UNESCO World Heritage sites or RAMSAR sites (United Nations list of protected areas).
- IBAT provides information on (the location of) HCVAs: maps offering information on the importance of priority sites for conservation, protected areas and the presence of threatened species.
- The IUCN Red List offers country specific information on areas where red list species are present.

It should be realised that not all information systems can be used for free. IBAT for example can not; for information on a specific area (within 50 kilometers of a site) a company pays 750 dollars while a bank itself, when it needs information on all the areas it invests in, would have to pay much more.

Investment policy options
Investment options resulting from the use of these data would be:

- A bank may decide not to invest in companies operating:
  - in or near HCVAs or protected areas
  - biodiversity rich areas
  - areas in which red list species/endangered species are present or depend on

- A bank may decide to only invest in companies operating near these areas under the condition that (at least one of the following options):
  - The company has carried out an Environmental Impact Assessment and subsequent actions to prevent a negative impact or preferably even provide for a positive impact.
  - The company has developed a biodiversity policy (Biodiversity Management Plan or Biodiversity Action Plan) and subsequent actions to prevent a negative impact or preferably even provide for a positive impact.
  - The area in which the activities take place is registered as a Verified Conservation Area (VCA). A VCA is an area that is managed privately, publicly or communally where ecosystems are restored, habitats protected and natural resources harvested sustainably. It showcases conservation action and provides assurance of conservation management (investment criterion: in case the company operates in or near HCVA's or protected areas or biodiversity rich areas/areas in which red list species/endangered species may be present and/or depend on, the area should be registered as a VCA).

Example: ASN Bank policy

- Following the IUCN Guidelines for Protected Area Management Categories
- Not developing activities that fall under the categories I-IV of the IUCN, the UNESCO World Heritage Convention and the Ramsar Convention on Wetlands
- Restoring the original ecosystem following the termination of the activities
- No draining of wetlands
- If using wood from ancient forests, only use of FSC-certified wood
- Only growing palm oil and soy in accordance with the criteria of for example the Brazilian Soy Platform and the Roundtable on Sustainable Palm Oil and only using second generation biomass.

Type of biodiversity loss
ReCiPe does not differentiate between protected, rare and common species, leaving insecurities with regard to the relevance of a species disappearance. The IUCN Red List monitors endangered and threatened species. Although it is impossible to establish whether investments actually led to impacts on one or more Red List species (without time consuming and possibly costly monitoring activities), one can establish if the activities a financial institution invests in take place in an area with Red List species. From a bodiversity perspective, the loss of an endangered species is worse than a reduction of the number of a common species.
Moreover, the likelyhood of reputation harm for a financial institution will be higher in case of impacts on endangered species.

Investment policy options
The policy options with regard to the issue of biodiversity loss are listed in the previous section on proximity of HCVA's/ protected areas and/or presence of endangered/threatened species.

Key drivers of biodiversity loss: invasive species
The potential introduction of invasive species mainly plays a role in the sectors 'aquaculture', 'agriculture', 'forestry', 'plant production' (by the use of non-native plant and soil material and phytosanitary risks) and 'transport' (for example through tourism or the spread of invasive species through ballast water). Some stakeholders will include Genetically Modified Organisms (GMOs) as (potentially) invasive species.

Investment policy options
A bank may decide to use invasive species related investement criteria for companies in 'high risk' sectors, like aquaculture, agriculture, forestry, plant production, transport and tourism.
Investment criteria can focus on proper management of the introduction of invasive species, including GMOs. Moreover, a financial institution could decide not to invest in companies working with GMOs (exclusion/divestment decision).

In some cases, sector specific sustainability initiatives will cover invasive species related criteria. For example, in the case of the paper wood sector, introduction of invasive species and GMOs would be covered through the use of sustainable forestry (FSC) criteria. Requiring this certification as part of the investment criteria will therefore cover the issue.

Sector specific information/recommendations with regard to biodiversity impacts will be covered in the sector specific qualitative analysis (see next chapter).

Key drivers of biodiversity loss: over-exploitation
Overexploitation may be relevant for sectors exploiting or processing biotic resources, like wood, fishery products or plant products.

Investment policy options
Investment criteria could focus on:
- No use of red list species (institutions aimed at protecting endangered species are excluded from this criterion)
- Companies/institutions must meet CITES requirements
- In case of 'high risk' sectors: Companies should assess a sustainable level of exploitation

Certification systems such as FSC (Forest Stewardship Council) for wood or MSC (Marine Stewardship Council) for fish provide a guarantee forthe prevention of overexploitation.

Key drivers of biodiversity loss: disturbance of fauna and ecosystems
Examples of disturbance include:
- Noise
- Light
- Physical disturbance (of ecosystems)
- Habitat fragmentation (resulting from the production site and from infrastructure directly resulting from production site activities, like transport of inputs and outputs and settlements of employees) (CREM, 2000)[5]

In many sectors, disturbance of fauna and ecosystems may result in an impact on biodiversity. Examples include agriculture/horticulture (e.g. light pollution), industry (e.g. habitat fragmentation, noise), fisheries (physical disturbance of seabeds) and tourism (noise, physical disturbance). An environmental impact assessment (EIA) can be used to gain insight in the relevance and significance of the impacts resulting from disturbance.

Investment policy options
A financial institution could require an EIA in case companies operate in or near a HCVA or protected area, a biodiversity rich areas or an areas in which red list species/endangered species are present. Based on the result, a financial institution could decide not to invest or only to invest if a company is adequately managing the (potential) impacts resulting from disturbance.

[5] Integral Biodiversity Impact Assessment System (IBIS), CREM, 2000 http://www.crem.nl/files/upload/documents/downloads/file/IBIS_Methodology_report_98_309.pdf

4 Footprint calculation & qualitative analysis ASN Bank

4.1 Introduction

This chapter provides an overview of the results from the quantitative analysis and the qualitative analysis for the investments of ASN Bank and Funds. The results of both analysis are presented per type of investment, allowing for a reflection on the quanitative analysis based on the results of the qualtitative analysis.

Apart from an interpretation of the results, like the identification of the main reasons for a specific impact score, recommendations regarding the impacts not (fully) covered by the quantitative analysis are provided as well. Either by recommending an adjustment of the quantitative footprint score, or by addressing these impacts through an investement policy (e.g. investment criteria preventing a negative impact from taking place).

The following types of investements are discussed:

- Government bonds
- Local governements
- Mortgages, housing corporations, sustainable buildings and renovations
- Sustainable energy projects
- Waterschappen (maintenance of waterways in the Netherlands)
- Equities
- Land restoration
- Others (Warmtenet, health and welfare…)

Please note that the complete results are not included in this report and are reported separately to ASN Bank.

4.2 Government bonds

This sections describes investments found in:

- ASN Bank
    - Government bonds
- Funds
    - Mix (government bonds)
    - Obligatie Fonds

4.2.1 Calculations

For each country, the total budget of the state for the reference year is extracted from the Exiobase dataset "Final consumption expenditure by government", from which we calculate the shares of this total budget that are actually supported by ASN Bank investments.

Dataset "Final consumption expenditure by government" are then computed for each country with the factor calculated.

$$\sum \left(\frac{ASN\ Invest_{Country_i}}{Budget_{Country_i}}\right) \times Final\ consumption\ expenditure\ by\ government\ (Country_i)$$

4.2.2 Interpretation of the results

The table below presents the results

State	*Investment from ASN Bank (in k€)*	*Total budget from Exiobase (in M€)*	*ha*	*m²/€*
Germany	1224811	431117	107179	0.88
The Netherlands	1153206	143497	178742	1.55
France	585759	432912	46308	0.79
Belgium	448842	74784	55252	1.23
Austria	216506	51663	15056	0.70
Sweden	20635	85749	1574	0.76
Total	**3649759**		**404110**	**1.11**
			Arithmetic average	0.98

The land-use related to statebonds is typically 1.11 m2 per Euro. A surprisingly large contributor is coming from the import of agricultural products from regions like Africa. This could also be an artefact of the way Exiobase has modelled Africa. For this region it did not find statistical data, and had to use extrapolated data.

4.2.3 Qualitative fine-tuning

The results of the qualitative anlysis are summarised in the table below.

Main impacts related to government bonds

Biodiversity impacts related to government bonds are diverse; all types of impacts are possible (impacts caused by land use, climate change, pollution, overexploitation, invasive species, disturbance).

Use of the qualitative analysis

One limitation of the quantitative analysis already mentioned in 4.2.2 is the way Exiobase has modelled Africa. This results in a relatively high impact of government bonds from Belgium (linked to coffee consumption). However, the qualitative analysis does not provide the input needed to correct this. Future, improved versions of Exiobase may solve this.

General recommendations investment policies

Assess countries on their biodiversity performance and take this into account in the selection of government bonds. For example:

- Require that countries must score well with regard to certain themes and international indices
- Exclude investments from countries that do not actively contribute to protecting biodiversity by not endorsing certain international treaties (see ASN Bank policy on state bonds)
- Exclude countries that are known for illegal trade and of which the government does not take enough efforts to prevent this (even if the CITES convention is signed)
- Explore other options to prevent/reduce biodiversity impacts of investing in government bonds by discussing the issue with, for example, IUCN or WWF.

Recommendations ASN Bank

- ASN Bank already has a strong policy in place. To verify whether the current policy is sufficient, ASN Bank could organize a consultation process/meeting with for example IUCN and WWF.
- The policy could potentially be expanded by excluding investments in countries that are known for illegal trade and of which the government does not take enough efforts to prevent this. A list that may potentially be used by investors is the CITES list of 'countries currently subject to a recommendation to suspend trade' (CITES, 2016). https://cites.org/eng/resources/ref/suspend.php

Example: policy ASN Bank state bonds

ASN Bank excludes investments from countries that do not actively contribute to protecting biodiversity by not endorsing the following international treaties to preserve biodiversity (main treaties the bank considers when evaluating bonds):

- Convention on Biological Diversity (CBD)
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
- Convention on the Conservation of Migratory Species of Wild Animals
- The International Treaty on Plant Genetic Resources for Food and Agriculture
- Convention on Wetlands (ook bekend als de Ramsar Convention)
- Unesco World Heritage Convention (WHC)
- UN Convention on the Law of the Sea
- Cartagena Protocol

ASN Bank further established that countries need to score well with regard to the following themes and international indices:

- Climate change (indicator: greenhouse gas emissions per capita)
- Share of sustainable energy (indicator: hydropower and sustainable energy as a percentage of the total electricity generated)
- Nuclear energy (indicator: use of production per capita)
- Water pollution (indicator: emissions of phosphate and nitrate in water)
- Air pollution (indicator: sulfur dioxide emissions per capita)
- Waste management (indicator: recycling of paper and glass)
- Nature conservation (indicator: share of the total protected area)

Sources qualitative analysis

- ASN Bank Biodiversity policy/ASN Bank Issuepaper Biodiversiteit – Bescherming van de diversiteit van organismen en ecosystemen, 2010.
- https://www.asnbank.nl/web/file?uuid=48507f9b-437a-4c04-87f3- 81a8a2196706&owner=9ccef6a9-c451-451a-963a-e931fe46c086&contentid=2207
- *CITES, 2016. "Countries currently subject to a recommendation to suspend trade"*, (Last update: 19/03/2015). https://www.cites.org/eng/resources/ref/suspend.php

4.3 Local governments

This section includes investments found in:

- ASN Bank
    - o Local governments

4.3.1 Calculations

With the exception of two lines of investments in UNEDIC and CADES in France, all other ASN Bank investments in local governments are occurring with municipalities in the Netherlands.
UNEDIC (Unemployment fund) and CADES (Social security fund) are modelled using Exiobase dataset "Health and social work (FR)".

Municipality budgets in the Netherlands are very transparent, and freely available at openspending.nl. We extracted the shares of each investment in the following sectors, linked to corresponding Exiobase datasets, and broke down the corresponding ASN Bank investments into each category.

Investment sector	*Exiobase dataset*
General management	Public administration and defence; compulsory social security (NL)
Public order and safety	Public administration and defence; compulsory social security (NL)
Traffic. Transportation and Public Works	Other land transport (NL)
Education	Education (NL)
Culture and Recreation	Recreational, cultural and sporting activities (NL)
Social Services and Social Services	Health and social work (NL)
Health And Environment	Health and social work (NL)
Spatial Planning and Housing	Public administration and defence; compulsory social security (NL)
Funding and General Coverage Resources	Public administration and defence; compulsory social security (NL)

4.3.2 Interpretation of the results
As there are many municipalities in this list we refer to the seprate report (for ASN Bank internal use) for the detailed results. The total biodiversity impact from this investment category is 71,947 hectares. The typical impact intensity is about the same as in the case of government bonds: 1.19 m^2/€. As we had more insights in the details of the expenditure, we have a reasonable confidence in the validity of this result.

4.3.3 Qualitative fine-tuning
The qualitative analysis for local government is comparable to that of state bonds: the impacts linked to these investements can be quite diverse and do not lead to a specific recommendation regarding the interpretation of the calculations. In deciding on investements in local government, a bank may decide to use investement criteria taking into account biodiversity performance. For the Netherlands however, this is probably not really necessary.

4.4 Mortgages, Housing corporations, sustainable buildings and renovations
Investments in this section are devided in 3 types: Loan for existing houses, construction of new buildings and renovation of existing buildings.
They are found in the following sections:
- ASN Bank
    - Mortgages (Loan for existing houses)
    - Residential construction (Construction of new buildings)
- Funds
    - EFO
        - Mix bespaar (Construction of new buildings)
    - Groenprojectenfonds
        - Mortgages (Loan for existing houses)
        - Newly constructed offices (Construction of new buildings)
        - Newly constructed houses (Construction of new buildings)
        - Renovation of houses (Renovation)

4.4.1 Calculations Mortages for existing houses
We considered, for existing houses, in coherence with what's explained in paragraph 2.3.2, that the impact is only caused by the occupation of the land and the energy expense arising from having a house occupied. We consider that each year a mortage is continued, the occupation of the land, and the energy used in that year can be related to the mortage. The transformation that may have occurred before the building was not considered, because we do not know whether such a conversion took place, and what the biodiversity value of the land was before it was converted.

Data used by ASN Bank for their Carbon Emissions reporting tool were made available to us:
- Number of houses that the total investment actually covers (a bit more than 50.000 houses), all in the Netherlands.
- An indication of the energy label of the houses financed. We used the average electricity and natural gas used per energy labels to calculate the energy consumption.
  Unfortunately, nearly 90% of the mortages cannot be related to an energy label. We had to extrapolate from this 10% over all houses.

- An average area used per house in the Netherlands (a bit more than 300m² per house, as on average there are about 30 houses per hectare in most suburbs). This means that apart from the house, the garden, also the communal spaces and roads are included.

From this data, we calculate the yearly impact, using the Exiobase datasets "Distribution and trade of electricity (NL)" and "Distribution of gaseous fuels through mains (NL)", and the direct total quantity of m² used for 50,000 houses.

Construction of new buildings
In the calculation of the mortages, we did not include the impact of construction, as this would lead to a double count; for mortages, we assume the house is already there, and the mortages are linked to energy consumption and the occupation of land. For construction we calculated the impacts of the use of the building materials and the building process itself. These calculations are based the computation of the investment with the Exiobase dataset "Construction (NL)".
This data does include an average impact of converting the land, but due to the nature of this data, this is modelled rather coarsely.

Renovation
Using the data gathered for energy consumption per type of label, and a list of all label changes before the renovation and after renovation, it could be possible to determine the amount of energy saved, and translate that into a biodiversity indicator using the same datasets from Exiobase. However, unfortunately we have been missing the time to collect and compute these data within the time frame of this project. For this reason, the calculation for renovation was not included.

4.4.2 Interpretation of the results
The results for mortages, an investment of € 4,535,878,000 (Verslag ASN Bank 2014: Duurzaamheidsverslag en financiële resultaten), can be summarised as follows. The biodiversity impact per invested Euro is relatively low; the impact of enery use is higher than the direct impact from the area occupied by the house.

Type	*Calculated expenditure on energy (k€/year)*	*Calculated area (Ha/yr)*	*Indicator m²/€*
Electricity usage	28595	7346	0.016
Natural gas usage	72345	15300	0.034
Land used by the houses	-	1622	0.004
Total		**24269**	**0.054**

The investments in construction are roughly a factor 10 lower than the investments in mortages (€ 475,893,000); the impacts on biodiversity are however half the impact of the mortages (111,146 hectare). The impact per euro is thus about 5 times as high compared to the mortages (2.34 m²/€).

4.4.3 Qualitative fine-tuning
The results of the qualitative anlysis are summarised in the table below.

Impacts related to mortgages/housing corporations/construction	
Negative impacts *The use of raw materials* • Land use • Energy use *The building process:* • Land occupation • Habitat loss and fragmentation • Disturbance (noise) • Pollution; soil, waste concrete, toxins in runoff or accidentally spilled fuels. • Energy use *The use phase of the building:* • Changes in lighting • Household rubbish • Disturbance by human activities • Energy use	Positive impacts (sustainable buildings) *Pro-biodiversity measures in construction* • Using pro-biodiversity products/building materials • Creating awareness for biodiversity • Providing a green environment: green roofs and green walls • Providing nesting space, urban habitats, etc. *Focus on pro-biodiversity in spatial planning* • Creating a green/blue infrastructure/corridors • Creating sustainable urban drainage systems (SUDS)

Use of the qualitative analysis

Impacts of buildings/housing may be more negative or more positive compared to ReCiPe footprint scores. This also depends on the type of investment category: mortgages, housing corporations or construction. For example, construction provides the option of including biodiversity positive building techniques (green roof, nesting space, etc.) and the use of biodiversity friendly building materials (e.g. FSC certified wood). Such building techniques may lead to a lower impact score than calculated based on average consstruction data.

General recommendations investment policies

Mortgages:
- Development of 'exclusion unless' criteria: Exclusion of investments in buildings/houses that negatively impact on biodiversity (either in the building process or as a building itself), unless negative impacts have been mitigated
- Investing in best in class only (e.g. for new biodiversity friendly buildings)

Possible steps include:
- Discussion of options for avoiding or mitigating biodiversity impacts and optimising positive impacts with the investee
- For new to build houses: location specific characteristics of the impacts should be taken into account in the building process

Housing corporations,options are:
- Development of 'exclusion unless' criteria: Exclusion of investments in housing corporations that possess buildings/houses that negatively impact on biodiversity (either in the building process or as a building itself), unless negative impacts have been mitigated for at least x % of the buildings/houses (e.g. 20%)
- Investing in best in class only: Investment in housing corporations with the highest number of 'best-in-class' buildings/houses

Possible steps include:
- Discussion of options for avoiding or mitigating biodiversity impacts and optimising positive impacts with the investee
- For new to build houses: location specific aspects of the impacts should be taken into account in the building process

Construction:
- Development of 'exclusion unless' criteria: Investments in construction only if specific biodiversity criteria are met
- Investing in best in class only: Investments limited to best-in-class buildings/houses only

Possible requirements are:
- Discussion of options for avoiding or mitigating biodiversity impacts and optimising positive impacts with the investee
- Location specific aspects of the impacts should be taken into account

Recommendations ASN Bank

ASN Bank may consider to implement one or more of the recommended investement policies. Investing in best-in-class would probably suit the ASN Bank policy best.

A more detailed qualitative analysis of mortgages, housing corporartions and construction is included in Annex C.

4.5 Sustainable energy projects

Investments in this section are devided in 4 categories: Wind energy, solar energy, biodigesters and other renewable energy. They are subdivided in the following sections:

- ASN Bank
  - Renewable energy
    - Wind energy
    - Solar energy
    - Other renewable energy
- Funds
  - EFO
    - Solar energy
      (investments in biodigestion, also included in EFO, have been interpreted as investments in solar energy)
  - Groenprojectenfonds
    - Biodigestion
    - Mix bespaar (Other renewable energy)
    - Mix energie (Other renewable energy, for NL only)
    - Wind op land (Wind energy)
    - Zonne-energie (Solar energy)

4.5.1 Calculations

For each project or organization in which ASN Bank invests, we used one of the following datasets:
- "Production of electricity by wind"
- "Production of electricity by solar photopholtaic"
- "Production of electricity by biomass or waste" We did this each time for the corresponding country.

Next we assumed that the energy produced would displace the average gridmix electricity in that country. We also calculated this for each country, using Exiobase. We then substracted the 'avoided' impacts from the impacts of producing the solar, wind or biomass powerplants. We had to collect the data on the actual production of the powerplants from various sources.

Taking the difference between the construction and the avoided average gridmix[6] is also the procedure for the climate impact calculations at ASN Bank. We consider this a conservative approach. In practice the addition of non fossil power will not replace the entire grid, but will influence the marginal producers. For instance, it is unlikely that the use of hydropower or nuclear will be affected by adding new wind, solar or biomas capacity. These sources have a high investment cost and low running costs. It is much more likely that the use of natural gas or coal will be affected. Another issue is that there is much exchange between countries. The French nuclear power is sold during nighttime to many countries, so it is not so clear whether it is realistic to have national gridmixes. As can be seen below, the effect of this approach is that investments in countries with a low carbon gridmix, like France, are not contributing to a lower biodiversity impact, while investing in countries that use much coal, such as the Netherlands, seems to be providing positive effects.

Other renewable energy
For projects or organisations which do not describe the type of energy in which they invest, we took the average intensity value (in m²/€) of all investments in renewable energy (in the ASN Bank portfolio) to calculate the number of hectares affected by the investment.
For the 'mix energie' category, since it is clear that the projects are only occurring in the Netherlands, we took the average of investments in the Netherlands only.

4.5.2 Interpretation of the results

Wind energy
The table below shows the burdens and benefits per windpark. The benefit of wind electricity is clear in countries with a relatively 'dirty' energy mix, as we are assuming that the production of wind energy will replace the average gridmix. In France we find that the gridmix has a really low impact, lower than the impact of wind energy. This is because of the high share of nuclear energy in the French gridmix, and nuclear energy causes significant less climate change than the other fossile energy sources. In the ReCiPe method the impact of nuclear radiation and biodiversity is not established, although ReCiPe does have a link between nuclear radiation and Human Health. This link is however not relevant in a biodiversity assessment and thus we cannot 'see' the impact of radiation and accidents in the biodiversity assessment.

The assumption that wind or solar energy replaces a national gridmix is compatible with the ASN Bank climate assessment, but is in fact a very conservative way to calculate this. When we look what actually happens in the energy market we will see that if more solar or wind energy enters the grid, the market will switch off those energy generation plants that have the highest marginal costs. Hydropower and nuclear energy plants are characterized by high investment costs and very low operating costs, so these will almost never be switched off. Fossil energy plants have relatively low investment, but high operating costs because they use so much fuel. It is therefore much more logical that these will be switched off first.and thus One can thus safely assume that solar and wind enery replaces fossil fuel based power generation, especially coal. This also applies in a country like France, that hardly has any fossil fuel based electricity production. However France is a relatively high exporter of electricity in Europe (because of the low costs of nuclear energy), so also a surplus of its production will lead to a reduction of fossil fuel in other countries.

[6] The term gridmix refers to the average supply mix of various types of energy production systems on an electricity grid. It can both refer to the physical gridmix (all powerplants that produce energy in a country or in Europe), as well as to the mix of the company that sells the electricity to the client/consumer.

Project	ASN Bank Investment (k€)	Country	Hectares	m²/€
Northwind N.V.	28993	BE	-15642	-2.21
Belwind N.V.	22643	BE		
C-Power N.V.	19184	BE		
Global Tech I Offshore Wind GmbH	27046	DE	-12719	-4.12
Trianel Windkraftwerk Borkum GmbH & Co. KG	3838	DE		
SFE-Parc Eolien de Leffincourt	8962	FR	249	0.28
Westermeerwind B.V.	12151	NL	-2973	-2.29
VAANSTER XIV BV "Terras aan de Maas"	760	NL		
VAANSTER SERVICES BV "Green Packages"	91	NL		
Total	**123668**		**-31085**	**-2.51**

Solar energy

Investments are in Belgium and France. Due to the way in which the avoided energy in the gridmix is calculated, there is no benefit of investing in France. In this case the total investment has no positive contribution to biodiversity, as is explained above under the windpower paragraph.

Project	ASN Bank Investment (k€)	Country	Hectares	m²/€
Belfuture 2 CVBA	8622	BE	-3205	-2.16
NPG Willebroek N.V.	6248	BE		
Sonnedix Rosières	22976	FR	3481	0.31
Centrale Photovoltaïque de Toul-Rosières 2	21472	FR		
Lavansol II SAS	14327	FR		
Centrale Photovoltaïque du Gabardan 2	14216	FR		
Newsolar SAS	11570	FR		
Lavansol M7 SAS	7747	FR		
SECP OLMO SAS	6913	FR		
FPV Pascialone SAS	6852	FR		
FPV Santa Lucia SAS	5259	FR		
Total	**126202**		**276.7554**	**0.022**

Other investments

We could not find enough data for the other investments in the table below to make any detailed calculations. We calculated the average biodiversity impact from investing in green energy, which is -1.7 m2/€, and multiplied the investment with this average, as can be seen in the table below. This result is of course a relatively uncertain extrapolation.

Project	ASN Bank Investment (k€)	Country	Hectares	m²/€
Europese Investeringsbank (Greenbond)	123140	EU	-20888	-1.70
NRW Bank (Sustainable bond)	82012	DE	-13912	-1.70
IDF	28352	FR	-4809	-1.70
Energiefonds Overijssel I B.V.	12000	NL	-2036	-1.70
Unica Financial Services B.V.	6677	NL	-1133	-1.70
Dif Infrastructure Fund	4501	EU – Nam	-764	-1.70
Dif Renewable Energy Fund	2727	EU	-463	-1.70
Eteck B.V.	2274		-386	-1.70
Impax New Energy Investors II	1395		-237	-1.70
BTES Art Court BV	585		-99	-1.70
Total	**263663**		**-44726**	**-1.70**

Green energy investments as a group

Overall the investments in green energy can be seen as a potentially strong contributor in a possible no-net-loss strategy. We think the potential is higher than we have calculated here, as the assumption that the energy produced in a country displaces average grid mix electricity is perhaps not the most realistic one. Under this conservative assumption we have an average benefit of 1.7 m^2/€, but if we take the example of windpower in Germany (which uses a lot of coal and lignite since it closed the nuclear powerplants), we see that the potential benefit could be around 4.5 m^2/€.

We do understand that the positive findings on nuclear energy may be counter intuitive, but it should be kept in mind that the disadvantages of nuclear energy are related to safety and human health. Nuclear power has no significant effect on biodiversity, apart from the impact of mining.

4.5.3 Qualitative fine-tuning

The results of the qualitative analysis, focusing on wind energy, are summarised in the table below.

Impacts related to mortgages/housing corporations/construction	
Negative impacts • Collisions with birds and bats • Displacement and deviation of migratory routes of birds and bats • Increased noise levels (offshore and terrestrial) • Electromagnetic fields • Introduction of invasive species (offshore) • Habitat loss (terrestrial)	**Positive impacts** • No fishing zones • Artificial coral reefs/ marine reserves (offshore) • Habitat enhancement • Positive land management (terrestrial)
Use of the qualitative analysis	
The information available on impacts of wind energy does not show whether negative impacts of wind parks outweigh the positive ones. This will highly depend on the location of the wind park and local biodiversity (including migration routes). It is therefore not recommended to adjust the ReCiPe footprint score. The potential positive and negative impacts can however be used in the development of investment criteria for wind parks.	
General recommendations investment policies	
• Take location specific characteristics of impacts into account in investment decisions (proximity of HCVA's and protected areas and presence of endangered/threatened species (see recommendations in chapter 3). • Discuss options for avoiding (1) or mitigating (2) negative impacts with the applicant e.g. a biodiversity management to prevent negative impacts 1) in the construction phase (e.g. by avoiding specific habitats and seasons) and 2) in the operational phase (the production of electromagnetic fields, for example, can be mitigated by proper cable design) (Bergström et al. 2014). • Do not invest in companies that do not manage negative impacts (exclusion). • Give priority to investments with clear positive contributions in the area (best in class).	
Recommendations ASN Bank	
The recommendations can be used by ASN Bank to further develop its policy on wind parks.	

A more detailed analysis of the potential impacts on biodiversity by wind parks is provided in Annex D.

4.6 Water Boards (Waterschappen)

In this sections are comprised investments found in:

- ASN Bank
    - o Waterschappen

4.6.1 Calculations

Budget details from the water boards in the Netherlands are freely available at openspending.nl. However, water bodies being a typical Dutch organisation type, it was not possible to relate the detailed budget lines to datasets in Exiobase (which is organised in sectors adaptable to every country).

From the ASN Bank climate tool, we extracted the total amount of CO_2 equivalent emissions arising from the activities of the water boards in 2014, from which we took the share financed by ASN Bank (i.e. ASN Bank investment devided by the sum of all budgets from water boards, obtained from openspending.nl).[7]

[7] The calculation was done on scope 1,2 and 3 based on https://www.uvw.nl/publicatie/klimaatmonitor-waterschappen- 2014/

4.6.2 Interpretation of the results

While we were able to calculate the negative impacts, mainly due to the CO_2 emissions, we could not really assess the probably very important positive impacts due to the way water boards manage large areas of land. The negative impacts were 1.3 m²/€.

4.6.3 Qualitative fine-tuning

Main impacts related to water boards

In realising their objectives regarding water safety and water quality, water boards both depend on biodiversity (e.g. for water purification purposes) and can have a strong impact on biodiversity as a result of water management and (for example) mowing practices of the river bank. By combining different functions in an area and cooperation with differernt stakeholders in an area (a landscape approach), both biodiversity and water safety/water quality can benefit. Concepts like building with nature offer innovative solutions in this area.

The of impacts (positive and negative) will vary in each area. The last few years have seen a growing interest in biodiversity by the different water boards in the Netherlands. In April 2016, the Green Deal 'Infranature' ('Infranatuur') was signed. Six water boards participate in this green deal which has the objective of improvig biodiversity using infrastructure.

Use of the qualitative analysis

Although it is not possible to calculate the positive impacts of water boards by means of the Exiobase/ReCiPe methodology, the pro-biodiversity initiatives by water boards can be supported by financial institutions by means of investments in these initiatives/projects.

General recommendations investment policies

- Make an inventory of pro-biodiversity inititaives of water boards and asess to what extent these initiatives can be supported by means of funding.

Recommendations for ASN Bank

ASN Bank already has a policy in place for water boards. By means of a more detailed inventory of pro-biodiversity initiatives at the various water boards, investments in water boards could be tailored to the (future) biodiversity objective of ASN Bank.

4.7 Equities

This section includes investments found in:

- ASN Bank
  - Rail transport
  - Other
- Funds
  - AAF
  - MWF
  - SMF
  - Mix (all except government bonds)

4.7.1 Calculations

Equities are the most complex type of investment to model, since every investment line represents a different company, i.e. different sectors of industry and different countries of operations. Given the high number of different companies, we decided to simplify the methodology, in order to limit both data collection and modelling and calculation time.
We selected the companies which represent the biggest investments for ASN Bank, in any case covering more than 30% of the total investment in one category of funds. ASN Bank collected data on NACE sectors in which they operate, as well as country of operations or production (including ratios of turnover or production in each country). For each company, we then built a model using Exiobase datasets closest to the NACE code, selected for each country. In case of significant investments for which these data were not available, we calculated the average intensity value (in m²/€) of all investments in the same NACE code to calculate the number of hectares affected. Finally, the indicator for all other ('non-significant') assessments was calculated by determining the average intensity value (in m²/€) of all previously calculated equities, and calculating back the number of hectares affected. The detail of each calculation is available in the separate report to ASN Bank.

4.7.2 Interpretation of the results

A detailed spreadsheet with all calculations per fund is supplied separately (internal report ASN Bank). The overarching results for the funds are as follows:

Fund name	*Investment (k€)*	*Impact (Ha)*	*Average m²/€*
AAF	582,148	181,646	3.13
MWF	292,017	90,582	3.10
SMF	54,872	17,201	3.13
Mix	174,432	35,429	2.03
EFO	77,665	17,608	2.27
Groenprojectenfonds	221,552	6,110	0.27
Bonds	19,378	19,378	0.97
Total	**1,347,009**	**342,617**	**2.54**

AAF

The investment with the highes biodiversity impact per euro are in food, chemical, publishing and printing as well as in apparel. These industries use much land and this determines their impact.

The top contributors are:

Company	*Investment (in k€)*	*Business sector (in Exiobase)*	*Country*	*ha*	*m²/€*
KEURIG GREEN MOUNTAIN INC	11160	Other food products	US (85%) CA (15%)	14040	12.58
STARBUCKS CORP	14661	Other food products	US (57%) KR (12%) CN (12%) GB (19%)	17357	11.84
NOVARTIS -REG	17720	Other chemicals and reproduction of recorded media	CN (24%) DE (33%) US (34%) BR (9%)	12562	7.09
PEARSON	7857	Publishing, printing and reproduction of recorded media	GB (12%) DE (7%) US (60%) CN (12%) BR (8%)	5196	6.61
INDITEX	10916	Manufacture of textiles and textile products	US (14%) CN (21%) ES (19%) GB (46%)	6795	6.22
MERCK & CO	11927	Other chemicals	US (48%) DE (33%) JP (21%) BR (8%)	6120	5.13

The lowest contributors are typically service companies; which is logical as they use very little space or materials. Investments in Asia and US (and middle East) have in general a relatively high impact.

MWF

Here we could find relatively little specific data, as these are all lesser known companies and organisations; much data needed to be extrapolated from just a few companies. This makes it relatively difficult to identify high and low contributors.

SMF

Also here we had to work with averages, which makes it diccicult to identify high and low contributors.

Mix

The mix fund contains of bonds and shares; the bonds have a lower impact compared to the shares.

State bonds	*Investment from ASN Bank (in k€)*	*ha*	*m²/€*
Total for bonds	99377	10092	0.97
Total for shares	75055	25337	3.38
Total for mixfund	**174432**	**35429**	**2.03**

EFO

This is an investment in construction and a fund called 'triple groen'. The latter has a positive contribution to biodiversity, but the investment is relatively small.

Groenprojectenfonds

This fund covers a wide range of relatively small investments that were difficult to research. Most of these are related to energy production and should thus have a positive contribution to biodiversity. A few relatively large ones, like the construction of new houses and the investment with warmtenet (Heatnet; district heating), were difficult to assess, as we do not really know how much energy is saved from this activity. We could only calculate the impact they have on biodiversity, not the benefit.

Bond (obligatie) fund

The impact of this fund is the same as presented above under State bonds, althought the size of distribution of the investment over the countries differ and it includes a few extra countries.

State	*Investment from ASN Bank (in k€)*	*Share of ASN Bank in the total statebonds*	*ha*	*m²/€*
Austria	35858	0.14%	2494	0.70
Belgium	21180	0.35%	2607	1.23
Spain	11143	1.73%	1155	1.04
Italy	9436	3.21%	820	0.87
Germany	30603	1.41%	2678	0.88
the Netherlands	38902	0.37%	6030	1.55
Portugal	10440	0.35%	1121	1.07
Ireland	7076	0.43%	405	0.57
France	26175	1.65%	2069	0.79
Total	**190813**		**19378**	**0.97**

4.7.3 Qualitative fine-tuning

An in depth analysis of all the sectors covered by ASN Bank's equities is beyong the scope of this project. To get a good uderstanding of what an in depth analysis would look like, such an analysis was made for the sectors Paper, packaging and Fashion. The results are presented in Annex E and the findings were used to decide on a less time consuming screening approach for all sectors. Results of this screening are presented in the matrix in Annex G. The matrix provides an overview of the linkages between (1) clusters of similar sectors (from the viewpoint of material use and/or economic activities) and (2) key drivers of biodiversity loss. It also includes (3) an indication of action perspectives for the investees. These action perspectives can again be used by investors to decide on investment criteria. The clusters that were used are based on ASN Bank's portfolio list (see annex F for the composition of each cluster).

Results of the analysis are summarized in the following section and are aimed at defining the clusters/sectors that may require extra attention from the viewpoint of positive or negative impacts on biodiversity. The matrix includes all main drivers of biodiversity loss, including those included in ReCiPe: land use, climate change and overexploitation of water (in ReCiPe water scarcity is included on a country level).

The analysis is used to assess for what sectors the results of the calculation may deviate from the impact on biodiversity in practice. Please note that the significance of this deviation cannot be assessed as this will depend on the local situation in the area of production and the company ASN Bank invests in. For example, if the matrix shows that for a specific cluster of sectors the introduction of invasive species is a *potentially* relevant issue, it could still be irrelevant for the companies ASN Bank invests in (because they are adequately managing the issue). It does mean however, that the issue could be included in the investment policy of the investor.

Risk sectors
In this qualitative analysis, 'risk sectors' are defined as sectors that score on specific drivers of biodiversity loss which are not covered by ReCiPe. This includes the following drivers:

- Introduction of invasive species
- Overexploitation; with regard to
  - Bioprospecting
  - Unsustainable use of wood
  - Overexploitation of fish
- Habitat fragmentation (as part of the driver 'disturbance')

Pollution and disturbance through noise are important risk factors for almost all clusters/sectors and can therefore not be used to identify specific clusters/sectors.

The ReCiPe results are dominated by land use, climate change and water use, but also calculate toxicity, acidification and eutrophication impacts. These, however, do not show up to be significant. This does not exclude the possibility that the impacts from pollution can still be significant in specific (more sensitive) locations (not showing up in average sector data). Moreover, certain emissions may not yet be fully captured in the Exiobase database and there are certain pollution impact pathways that are not covered in ReCiPe, like the impact of microplastics[8]. This should be kept in mind when interpretating the footprint results. For a specific company in a specific location, the impact of pollution could still be significant.

Introduction of invasive species
Sectors in which the introduction of non-native species or introduction of GMO's plays a role are mainly agricultural based and forestry based. Main clusters include:

- Food & beverage (agriculture)
- Fashion & textiles (agriculture)
- Paper (forestry)
- Construction (forestry)
- Mortgages and housing corporations, if construction is included in the focus (forestry)
- Furniture (both agriculture and forestry

Bioprospecting as a cause of overexploitation
Bioprospecting (the search for biotic resources as a basis for new products) is an important reason for overexploitation of biotic resources. Clusters in which bioprospecting plays a role are:

- chemicals & chemical products (as pharmaceuticals are part of this group)
- household goods & personal products (as caring products/cosmetic products may also be based on the search for new active ingredients)

Overexploitation of wood
The use of non-sustainable wood is also an important cause of overexploitation. Sectors in which this may play a role include:

- Paper
- Construction
- Mortgages and housing corporations, if construction is included in the focus
- Furniture

Overexploitation of fish
This plays a role within the cluster:

- Food & beverage

[8] For example http://www.nature.com/news/microplastics-damage-oyster-fertility-1.19286

Habitat fragmentation
Habitat fragmentation is an important cause of disturbance with regard to biodiversity. Habitat fragmentation may be agricultural related, industry related or forestry related. Clusters in which habitat fragmentation is an important issue are:

- Renewable energy (production of biomass)
- Food & beverage (agriculture related)
- Fashion and textiles (agriculture related)
- Household goods & personal products (both agricultural as well as industry related)
- Chemicals & chemical products and metal & rubber production (industry related)
- Paper and furniture (forestry related)
- Rail transport or building (infrastructure)
- Landscape (new nature): may have a positive effect on habitat fragmentation

Clusters with a positive impact
Some clusters may have a positive impact on the drivers that are included in ReCiPe. Examples are:

- Renewable energy (habitat creation in case of offshore wind parks through the creation of artificial reefs and the creation of no fishing zones)
- Water extraction & management (habitat creation in areas where nature is used to manage water quality)

Summary of risk sectors
The table below lists the main risk sectors (clusters) that result from the qualitative analysis, including the reasons why.

Main (risk) sectors based on qualitative analysis	**Relevant issues**
Food and beverage	• Introduction of invasive species • Overexploitation of fish • Habitat fragmentation
Fashion and textiles	• Introduction of invasive species • Habitat fragmentation
Paper	• Introduction of invasive species • Overexploitation of wood • Habitat fragmentation • Secundary impacts forestry, like settlements and economic activities around the forestry location
Mortgages, housing corporations & sustainable buildings	• Introduction of invasive species • Overexploitation of wood • Habitat fragmentation
Furniture	• Introduction of invasive species • Overexploitation of wood • Habitat fragmentation
Chemicals & chemical products	• Bioprospecting (overexploitation) • Habitat fragmentation
Household goods and personal products	• Bioprospecting (overexploitation) • Habitat fragmentation
Sectors with a potential positive impact	
Landscape (new nature)	• Habitat fragmentation (positive effects) • Land use (positive effects)
Renewable energy (wind energy)	• Land use (positive effects)
Water extraction and management	• Land use (positive effects)

4.8 Summary results

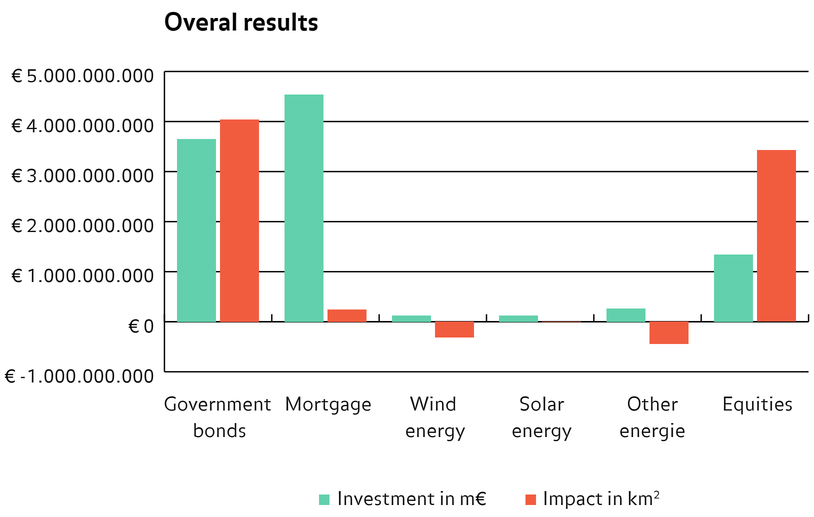
The table below summarises the results from the previous chapters; negative figures represent positive impacts, and are printed in green.

	Investments in m€	*Impact in km²*	*Index m²/€*
Government bonds	3,700	4,000	1.11
Mortages	4,600	240	0.05
Wind energy	120	- 310	- 2.51
Solar energy	130	3	0.02
Other energy	260	- 450	- 1.70
Equities	1,300	3,400	2.54
Total	**10,000**	**7,000**	**0.69**
Reference		6,382	

The overall result is that the current investment portfolio causes an impact of 7,000 PDF.km².yr. This means that an area of 7,000 km² loses all its diversity during a year. It can also be interpreted as an area of 70,000 km² loses 10% of its diversity. Please note that this occupied area is stable as long as ASN Bank keeps its portfolio as it was analysed. It does NOT mean that each year an area of that size is being added to the damage.

We tried to find a good reference for a region of that size, and found that the combined area of the provinces of Noord- and Zuid Holland has a very similar size (6,382 km²). Other references are for instance the US state of Delaware (6,452 km²), Puerto Rico or Cyprus, both around 9,000 km².

The results can also be represented as the following graph:

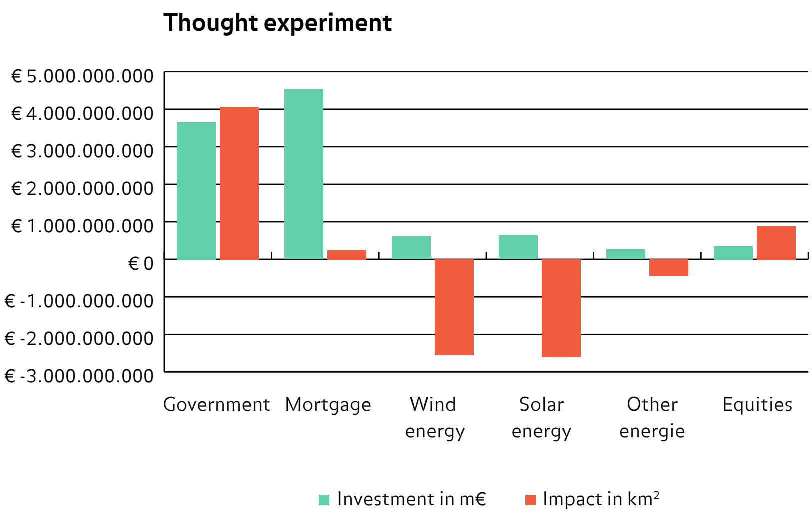


4.9 A thought experiment

The results can be used to develop an insight in the impact of investments scenarios. While stressing that the following is a completely fictional example, not in any way approved or endorsed by ASN Bank, we conducted the following thought experiment:

1. Suppose we calculate the avoided emissions from solar and windpower in a less conservative way, and we assume that new wind and solar production will replace the European gridmix instead of the national gridmix in the country where the investment is made (see the remarks in section 4.5.2).
2. Suppose the investments in solar and wind energy each, are five times as high as they are now, at the expense of the investments in equities.
3. Suppose the main investments in equities deal with services.

Under these conditions, the impacts of the investment portfolio would almost become zero or even net positive (minus 400 km²); this is illustrated in the graph below.



5 Conclusions and recommendations

5.1 Conclusions

The methodology

- **Too simple or too complex?**
  In many ways ReCiPe oversimplifies the complex relationships between economic activities and biodiversity, and as we have seen this relative simplicity needs to be enriched by qualitative data. At the same time one can also argue that ReCiPe is far too sophisticated and complex, and it is really difficult for an auditor to understand the validity. For Exiobase and ecoinvent something similar holds true: it is not really possible for an auditor to verify the correctness of the data in such databases, as the data comes from all kinds of sources.

  During the pilot the problem of auditing became more and more an issue, and some thoughts/recommendations have been developed based on the experiences in this pilot.

- **Simplification based on the most important drivers?**
  When we analyse the most important drivers for the biodiversity impacts we see that more than 90% of the impacts come from land-use and climate change, sometimes water scarcity plays a significant role. This means we could consider leaving out all impact categories that do not seem to play a significant role in the total footprint.

  We think this is also a result of the sectors in wich ASN Bank invests: Toxicity, eutrophication and acidification become significant when investing in mining, fossil fuels, and agricultural practices that use a lot of pesticides and phosphates, but ASN Bank has already excluded these. However, it must be realised that a calculation which incudes the supply chains linked to an investment will also include impacts from sectors excluded from direct investments (e.g. investing in the retail sector of apparel wil also lead to indirect impacts in cotton production).

- **The challenge of assessing positive impacts**
  In the quantitative analysis, some positive impacts could be included quite well, some could not. In the green energy assessment the approach used for climate (carbon footprinting) was followed: the production of renewable energy will lead to the avoidance of the energy produced according to the gridmix. In this way a positive contribution could be calculated, even though the assumption was a conservative one, for two reasons:
  - Energy grids are strongly interlinked, so the national gridmix has no real meaning.
  - If new green energy instalations are put in operation, electricity companies will only lower the use of powerplants that have a relatively high fuel cost, and not those whose costs are determined mainly by the investment costs, such as hydropower and nuclear; these will continue to produce. So it is defendable to assume that the avoided energy comes from fossil powered powerplants. This means that the positive contribution is probably higher than was calculated.

  The positive impacts of other investments are also not so easily determined. For instance the impact of water boards, the impact of district heating, and the investment in low energy houses are areas where we were unable to capture this.

  This limitation has consequences for assessing the potential of a net zero loss (no-net-loss) for biodiversity, but we see possibilities to further improve our understanding of the positive impacts of these investment categories.

- **The qualitative analysis to capture 'invisible' impacts**
  The qualitative analysis provides a good way of determining potential impacts (positive or negative) which may not be capatured by the Exiobase/ReCiPe calculation. This includes drivers of biodiversity loss which are not included in the ReCiPe methodlogy, like overexploitation and the introducton of invasive species. However, since impacts in most cases highly depend on local circumstances, these findings are not easily translated into a correction of the calculated impact score.

- **Using qualitative results for policy development**
  Though the results of the qualitative analysis cannot be easily translated into a corrected footprint score, these results can be used to address impacts, both positive and negative, through investment criteria and engagement with investees. The same is true with the results of the quantitative analysis at the level of 'mid-point' indicators and environmental effects (like emissions) showing what the main reasons for an impact score are.

The process

- The process of calculating ASN Bank's biodiversity footprint and the process of developing a long term biodiversity objective have been quite valuable in itself. The process included interviews with experts and policy makers and a stakeholder meeting where the results were discussed. Stakeholders participating in this meeting included representatives from government, methodological experts and representatives of cicil society organisations. The process has shown what decisions and challenges a financial institution may face when assessing its impact, when deciding on its responsibility and when working towards a biodiversity objective. The process has also shown how different stakeholders look at these decisions and challenges. Moreover, the process has created a basis for a network of experts and stakeholders that ASN Bank can consult and involve in the process in the coming years.

The footprint analysis

- **Interpretation with care**
  The methodology is still a draft method, which has been used to produce quantitative information that, as such, is not sufficiently reliable to be used for external communication or to base detailed investment decisions on. To use the results, they need to be interpreted taking into account the limitations of the methodology and the results of the qualitative analysis. In this way, the methodology shows what the impact 'hot spots' are and where further detailing of the calculations may be of value.

- **Valuable insights in relative impacts of different investments**
  The quantitative analysis provides insight in the biodiversity impact per invested Euro (impact intensity). Taking the limitations of the methodlogy into account, the footprint calculatons provides valuable insights in the investments of ASN Bank. Some of these insights are:
  - The investements in local government have an impact comparable to (though slightly higher than) investments in state bonds.
  - The impact of investments in construction is relatively high compared to mortgages (factor 5).
  - In mortgages, the impact of energy use plays a more important role than the impact of land use.
  - Investments in green energy can be seen as a potential strong contributor to a no net loss strategy. The potential is probably even higher than calculated, when the calculation is based on more detailed data of the energy sources replaced (for example green energy replacing energy production from coal).
  - Investments in equity have a relatively high impact on biodiversity compared to state bonds, local government, mortagages and construction.
  - The impact of investments in equity are highest for food, chemical, publishing and printing and apparel. Land use is the main reason for this, e.g. resulting from agricultural land use (for food production and cotton production for textiles) and forestry (for wood production used in the paper industry).

- **Part of the positive contributions cannot be calculated**
  The positive contributions of investements in water boards and Green Projects (projects part of the Dutch 'Green Projects Scheme') could not be calculated due to the lack of data and/or the fact that budget lines could not be related to datasets in Exiobase.

- **Qualitative fine-tuning**
  The qualitative analysis shows that the footprint calculated might be different (more positive or more negative) when drivers for biodiversity loss not covered by ReCiPe are taken into account. For example, this is true for sustainable production practices (e.g. organic agriculture or FSC forestry) and specific positive impacts (e.g. no fishing zones around offshore wind parks). The deviations from the footprint score will highly depend on the local biodiversity circumstances and the company ASN Bank invests in. In case of working towards a no-net-loss objective, the bank may consider to further look into the potential correction of impact scores.

- **Positive effects of a strong biodiversity policy**
  Since ASN Bank already has a lot of biodiversity related investment criteria in place (e.g. on FSC certified forestry), one would expect that the actual footprint of ASN Bank is probably lower than calculated when average impact data are used. An example could be the relatively high impact of investments in publishing and printing where the use of FSC certified paper could reduce the impact significantly.

No-net-loss

- The results of the footprint calculation can be used to focus on the 'impact hot spots' to avoid or mitigate the impact on biodiversity through the investments of ASN Bank. For example by further developing the investement criteria based on the results of the calculations and the qualitative analysis. This will contribute to a potential no net loss strategy, even though it is not yet clear if and when a no net loss might be reached.

- Looking at the calculations, investments in sustainable, green energy can play an important role in reaching a no net loss situation or at least compensate for part of the impact of ASN Bank. By using a more accurate calculation methodology this contribution will even be higher than calculated.

- The fact that part of the positive impacts that ASN Bank will have through its investments in water boards and green projects cannot be calculated yet means that it is not possible to calculate exactly what is still needed to realise a no net loss situation.

5.2 Recommendations

The results of the footprint analysis and the steps taken to formulate a long term biodiversity objective for ASN Bank are not an end, but rather a beginning. The beginning of a process of deciding on the long term objective within the bank, of working towards this objective in cooperaton with experts and stakeholders and of optimizing the footprint methodology while doing so. In this section, a number of recommendations is presented to guide possible next steps.

Methodology

Simplification
If we would only focus on the 'big three' from an impact point of view, land-use, climate change and water scarcity, the methodology could be simplified as follows:

- For carbon, we can use the carbon impacts that are already calculated by ASN Bank, and convert these with the characterisation factor from ReCiPe. This can be calculated as each kg of CO_2 equivalents causes a damage of 0.54 PDF.m2.yr.
- While we assume ASN Bank does not invest in activities that significantly contribute to the conversion of nature into agricultural, industrial or mining, we can for now omit this aspect. If later other banks are invited to use the method, this simplification may be reconsidered. It is of course important that an auditor is able to check this assumption.

For the issues around Exiobase, especially the poorly understood high impacts from agricultural practices in the rest of the world regions, we see two solutions:
- Simply ignore inputs from these regions, or try to estimate the mass that is being imported, and model these with ecoinvent.
- Switch to Exiobase version 3, and recalculate, assuming this will better specify the various land-use types, allowing us to use a more appropriate characterisation factor for very extensive land-use practices.

Further improvement
In the long run, but this needs significant research, we could improve the method further:

- For land occupation, we could refrain from using the regional effect (the effect that biodiversity will not only decrease in the area where an activity takes place, but also in the remaining area around it, due to its reduced size), as this has a relatively complex background, and only use the local effect. We could also simplify the rather subtle differences between various agricultural uses, but keep the distinction between levels of extensiveness of the use. We may want to add other ways of defining the extensiveness:
  - Forest under FSC and other certificates
  - Organic farming practices
  - Improving areas such as done by the waterboards and other institutions.
  - Etc.

- For water the method asks for knowing in which country we are in, but in fact a country classification is not always useful. An alternative is to specify water use per biome, as waterstress is often correlated to the type of biome. This has some advantages:
  - Most agricultural products only flourish in one or a very limited number of biomes, so if the country of origin is not known often the biome can be estimated.
  - There are far less biomes than countries, which would simplify the database.
  - Biomes, and impacts on biomes can be relatively easily monitored with earth observation technologies.
- If we can model biomes for water, we may also be able to improve the land-use factors per biome.

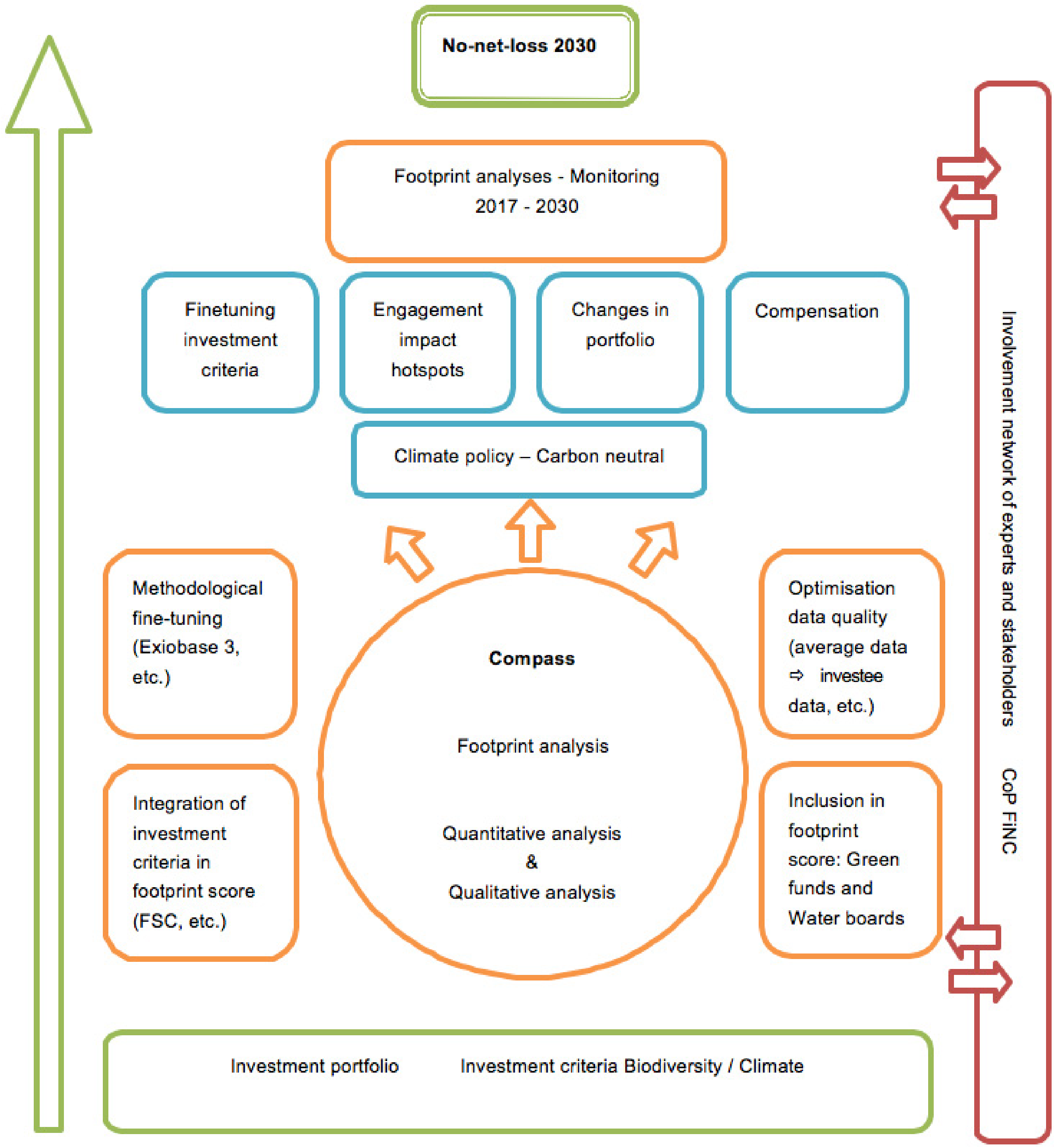
The footprint analysis
- It is recommendend that the results of the footprint analysis, including the qualitative analysis, are used by ASN Bank to assess whether the bank's policy on biodiversity matches the 'impact hot spots' and 'risk sectors' identified. Based on the results, the policy could be fine-tuned where relevant.
  When adjusting the bank's biodiversity policy to the results of the footprint analysis, the bank may need to decide whether it divests from certain high impact sectors or it engages with investees in high impact sectors to urge them and support them to change their practices.

- As discussed before, it could be interesting to determine how the footprint calculated by ReCiPe/Exiobase relates to the concept of ecosystem services. Should biodiversity be used as an indicator of healthy ecosysems and therefore as a proxy for the continued delivery of ecosystem services? Or can ReCiPe calculations be used to link environmental effects and impacts on a mid-point level to impacts on specific ecosystem services? And what would this mean for ASN Bank?

No-net-loss
- The insights from the footprint analysis can be used by ASN Bank to tailor its investment portfolio to a long term biodiversity objective (to be determined). If this objective is a no-net- loss situation or a net positive contribution, then each shift from relatively high impact investments to low/positive impact investments will contribute to this goal.

Communication
In its communication with stakeholders, ASN Bank can consider to illustrate the process towards its long term biodiversity goal with a 'biodiversity dashboard' showing the different actions the bank will work on, either parallel or consecutive. An example of such a dashboard is included on the next page.

Example of ASN Bank's 'Biodiversity dashboard'



Annex A: list of sectors in exiobase

1 Cultivation of paddy rice (NL)
2 Cultivation of wheat (NL)
3 Cultivation of cereal grains nec (NL)
4 Cultivation of vegetables, fruit, nuts (NL)
5 Cultivation of oil seeds (NL)
6 Cultivation of sugar cane, sugar beet (NL)
7 Cultivation of plant-based fibers (NL)
8 Cultivation of crops nec (NL)
9 Cattle farming (NL)
10 Pigs farming (NL)
11 Poultry farming (NL)
12 Meat animals nec (NL)
13 Animal products nec (NL)
14 Raw milk (NL)
15 Wool, silk-worm cocoons (NL)
16 Manure treatment (conventional), storage and land application (NL)
17 Manure treatment (biogas), storage and land application (NL)
18 Forestry, logging and related service activities (02) (NL)
19 Fishing, operating of fish hatcheries and fish farms; service activities incidental to fishing (05) (NL)
20 Mining of coal and lignite; extraction of peat (10) (NL)
21 Extraction of crude petroleum and services related to crude oil extraction, excluding surveying (NL)
22 Extraction of natural gas and services related to natural gas extraction, excluding surveying (NL)
23 Extraction, liquefaction, and regasification of other petroleum and gaseous materials (NL)
24 Mining of uranium and thorium ores (12) (NL)
25 Mining of iron ores (NL)
26 Mining of copper ores and concentrates (NL)
27 Mining of nickel ores and concentrates (NL)
28 Mining of aluminium ores and concentrates (NL)
29 Mining of precious metal ores and concentrates (NL)
30 Mining of lead, zinc and tin ores and concentrates (NL)
31 Mining of other non-ferrous metal ores and concentrates (NL)
32 Quarrying of stone (NL)
33 Quarrying of sand and clay (NL)
34 Mining of chemical and fertilizer minerals, production of salt, other mining and quarrying n.e.c. (NL)
35 Processing of meat cattle (NL)
36 Processing of meat pigs (NL)
37 Processing of meat poultry (NL)
38 Production of meat products nec (NL)
39 Processing vegetable oils and fats (NL)
40 Processing of dairy products (NL)
41 Processed rice (NL)
42 Sugar refining (NL)
43 Processing of Food products nec (NL)
44 Manufacture of beverages (NL)
45 Manufacture of fish products (NL)
46 Manufacture of tobacco products (16) (NL)
47 Manufacture of textiles (17) (NL)
48 Manufacture of wearing apparel; dressing and dyeing of fur (18) (NL)
49 Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear (19) (NL)
50 Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials (20) (NL)
51 Re-processing of secondary wood material into new wood material (NL)
52 Pulp (NL)

53 Re-processing of secondary paper into new pulp (NL)
54 Paper (NL)
55 Publishing, printing and reproduction of recorded media (22) (NL)
56 Manufacture of coke oven products (NL)
57 Petroleum Refinery (NL)
58 Processing of nuclear fuel (NL)
59 Plastics, basic (NL)
60 Re-processing of secondary plastic into new plastic (NL)
61 N-fertiliser (NL)
62 P- and other fertiliser (NL)
63 Chemicals nec (NL)
64 Manufacture of rubber and plastic products (25) (NL)
65 Manufacture of glass and glass products (NL)
66 Re-processing of secondary glass into new glass (NL)
67 Manufacture of ceramic goods (NL)
68 Manufacture of bricks, tiles and construction products, in baked clay (NL)
69 Manufacture of cement, lime and plaster (NL)
70 Re-processing of ash into clinker (NL)
71 Manufacture of other non-metallic mineral products n.e.c. (NL)
72 Manufacture of basic iron and steel and of ferro-alloys and first products thereof (NL)
73 Re-processing of secondary steel into new steel (NL)
74 Precious metals production (NL)
75 Re-processing of secondary preciuos metals into new preciuos metals (NL)
76 Aluminium production (NL)
77 Re-processing of secondary aluminium into new aluminium (NL)
78 Lead, zinc and tin production (NL)
79 Re-processing of secondary lead into new lead (NL)
80 Copper production (NL)
81 Re-processing of secondary copper into new copper (NL)
82 Other non-ferrous metal production (NL)
83 Re-processing of secondary other non-ferrous metals into new other non-ferrous metals (NL)
84 Casting of metals (NL)
85 Manufacture of fabricated metal products, except machinery and equipment (28) (NL)
86 Manufacture of machinery and equipment n.e.c. (29) (NL)
87 Manufacture of office machinery and computers (30) (NL)
88 Manufacture of electrical machinery and apparatus n.e.c. (31) (NL)
89 Manufacture of radio, television and communication equipment and apparatus (32) (NL)
90 Manufacture of medical, precision and optical instruments, watches and clocks (33) (NL)
91 Manufacture of motor vehicles, trailers and semi-trailers (34) (NL)
92 Manufacture of other transport equipment (35) (NL)
93 Manufacture of furniture; manufacturing n.e.c. (36) (NL)
94 Recycling of waste and scrap (NL)
95 Recycling of bottles by direct reuse (NL)
96 Production of electricity by coal (NL)
97 Production of electricity by gas (NL)
98 Production of electricity by nuclear (NL)
99 Production of electricity by hydro (NL)
100 Production of electricity by wind (NL)
101 Production of electricity by petroleum and other oil derivatives (NL)
102 Production of electricity by biomass and waste (NL)
103 Production of electricity by solar photovoltaic (NL)
104 Production of electricity by solar thermal (NL)
105 Production of electricity by tide, wave, ocean (NL)
106 Production of electricity by Geothermal (NL)
107 Production of electricity nec (NL)
108 Transmission of electricity (NL)

109 Distribution and trade of electricity (NL)
110 Manufacture of gas; distribution of gaseous fuels through mains (NL)
111 Steam and hot water supply (NL)
112 Collection, purification and distribution of water (41) (NL)
113 Construction (45) (NL)
114 Re-processing of secondary construction material into aggregates (NL)
115 Sale, maintenance, repair of motor vehicles, motor vehicles parts, motorcycles, motor cycles parts and accessoiries (NL)
116 Retail sale of automotive fuel (NL)
117 Wholesale trade and commission trade, except of motor vehicles and motorcycles (51) (NL)
118 Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods (52) (NL)
119 Hotels and restaurants (55) (NL)
120 Transport via railways (NL)
121 Other land transport (NL)
122 Transport via pipelines (NL)
123 Sea and coastal water transport (NL)
124 Inland water transport (NL)
125 Air transport (62) (NL)
126 Supporting and auxiliary transport activities; activities of travel agencies (63) (NL)
127 Post and telecommunications (64) (NL)
128 Financial intermediation, except insurance and pension funding (65) (NL)
129 Insurance and pension funding, except compulsory social security (66) (NL)
130 Activities auxiliary to financial intermediation (67) (NL)
131 Real estate activities (70) (NL)
132 Renting of machinery and equipment without operator and of personal and household goods (71) (NL)
133 Computer and related activities (72) (NL)
134 Research and development (73) (NL)
135 Other business activities (74) (NL)
136 Public administration and defence; compulsory social security (75) (NL)
137 Education (80) (NL)
138 Health and social work (85) (NL)
139 Incineration of waste: Food (NL)
140 Incineration of waste: Paper (NL)
141 Incineration of waste: Plastic (NL)
142 Incineration of waste: Metals and Inert materials (NL)
143 Incineration of waste: Textiles (NL)
144 Incineration of waste: Wood (NL)
145 Incineration of waste: Oil/Hazardous waste (NL)
146 Biogasification of food waste, incl. land application (NL)
147 Biogasification of paper, incl. land application (NL)
148 Biogasification of sewage slugde, incl. land application (NL)
149 Composting of food waste, incl. land application (NL)
150 Composting of paper and wood, incl. land application (NL)
151 Waste water treatment, food (NL)
152 Waste water treatment, other (NL)
153 Landfill of waste: Food (NL)
154 Landfill of waste: Paper (NL)
155 Landfill of waste: Plastic (NL)
156 Landfill of waste: Inert/metal/hazardous (NL)
157 Landfill of waste: Textiles (NL)
158 Landfill of waste: Wood (NL)
159 Activities of membership organisation n.e.c. (91) (NL)
160 Recreational, cultural and sporting activities (92) (NL)
161 Other service activities (93) (NL)
162 Private households with employed persons (95) (NL)
163 Extra-territorial organizations and bodies (NL)

Annex B: references

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CREEA booklet, The Global Resource Footprint of Nations Carbon, water, land and materials embodied in trade and final consumption calculated with EXIOBASE 2.1. Arnold Tukker, Tatyana Bulavskaya, Stefan Giljum, Arjan de Koning, Stephan Lutter, Moana Simas, Konstantin Stadler, Richard Wood

References used for the qualitative analysis are included in the results of the qualitative analysis (annex C – E).

Annex C: qualitative analysis mortgages, housing corporations and construction

Main impacts related to mortgages, housing corporations and construction
Main impacts related to (investments in) buildings - and thus related to mortgages and housing corporations - concern:

- The use of raw materials (building materials), including the land use and energy use needed to produce these materials.
- The building process:
    - o Land occupation of the building (urban infrastructure); loss and fragmentation of natural habitats (Secretariat of the Convention on Biological Diversity, 2010)
    - o Disturbance caused by the construction process; noise from construction activities disturbing fauna, resulting in their relocation (Notice Nature, 2016)
    - o Pollution: soil, concrete and toxins in runoff from construction sites can enter watercourses; the same is true for fuels, accidentally spilled during storage or delivery. These pollutants can impact on aquatic habitats, plant life, invertebrate and all life stages of fish. (Notice Nature, 2016)
- The use phase of the building: (1) Changes in lighting, (2) presence of household waste, (3) disturbance by human activities (Notice Nature, 2016)

Some of these impacts may be mitigated by sustainable building practices', like the use of ecodesign[9]:
- Changing the concept: can the need of the customer be met in a different, more sustainable way?
- Changing the design: less material/weight, more recycled material, longer life span, multi functional use, ease of disassembly etc.
- Choosing materials with a relatively low impact on biodiversity

A building may also result in positive contributions to biodiversity, e.g. in case of pro-biodiversity measures in spatial planning (creation of water ways, green corridors) and construction (green roofs, nesting facilities, etc.). Examples of pro-biodiversity measures are provided in the table below.

[9] For more information on ecodesign, see for example the Okala Ecodesign Strategy Wheel (Belletire, S. et al., 2012) or the Eco-design guide (ECOLIFE Thematic Network, 2002).

Table: Examples of positive contributions to biodiversity of buildings

Pro-biodiversity measures in construction	
Providing a green environment: green roofs and green walls	The biodiversity benefits of green roofs and green walls include (Damen and Brouwers, 2012) (Marks & Spencer, 2015): • More biodiversity in urban environment • Providing nectar/food /schelter/nests • Prevention of pollution (uptake particulates and NOx) • Combating climate change (due to lower energy consumption and CO_2 absorption) • Water storage function • Awareness with regard to biodiversity (Greenroofs.com, 2016: examples green roofs/walls)
Providing nesting space, urban habitats, etc.	• Bat and bird boxes and bricks are attached to the building façade or incorporated into the fabric of the building. They are usually either designed for bats or birds (sometimes both) and provide a place for them to nest, roost, hibernate and rear their young. A wide variety of bat and bird boxes and bricks are available to meet the requirements of different species.The modern need for low carbon buildings has led to changes in construction techniques and materials and increasingly airtight buildings present fewer opportunities for many bird and bat species. Incorporating simple design features can provide nesting and roosting potential that would otherwise be lost. (Marks & Spencer, 2015). • Insect boxes (BREEAM, 2013) • Native vegetation that attracts specific (endangered) species like flowering plants for bees (European Commission, 2015), butterfly bushes and plants or trees/shrubs with food, nesting and shelter for birds etc. (providing a green environment of buildings, business area's etc.) • Installation of bat and bird friendly lighting through: (1) the use of motion sensors (2) by hanging the lighting low and/or protection at the top of the lighting (Milieukeur, 2015)
Use of pro-biodiversity products/building materials	• Choosing pro-biodiversity products/building materials: materials produced in a way that it sustains biodiversity; e.g. produced with low impact and providing value to a nature area that might otherwise disappear
Creating awareness for biodiversity	• Creating awareness for biodiversity through design/communication. Specific building features offer an opportunity to educate building users and communities on the importance of biodiversity (e.g. green roofs, new landscape planting, dry stone walling) (Marks & Spencer, 2015)
Spatial planning	
Creating a green/blue infrastructure (green/blue corridors)	• Water ways • Vegetation corridors: Ecological corridors that are linked to the surrounding landscape or urban park network (connecting green spaces) raise the value of the urban ecological system (de Roo, 2011). Existing natur/water/topographical characteristics of an area are used best as starting points to guide the planning and location of the network. The biodiversity guide of the Dutch Province Noord-Brabant gives insight into ways to contribute to biodiversity in spatial planning (e.g. buildings, green infrastructure etc.) (Province Noord- Brabant, 2012)
Creating sustainable urban drainage systems (SUDS)	• Sustainable Urban Drainage Systems (SUDS) can help to protect and enhance biodiversity by reducing the impact of urban runoff on watercourses. Certain SUDS types can provide a range of habitats for native plants and wildlife including reeds, fish, amphibians, birds and invertebrates (by creating new wetland habitat). Although the primary function of SUDS is to manage surface runoff, strategic planting within SUDS can support an increase in local biodiversity (Marks & Spencer, 2015).

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Annex D: qualitative analysis wind parks

Impacts offshore wind parks and terrestrial wind parks

The tables below provide an overview of the potential negative and positive impacts of offshore wind parks and terrestrial wind parks.

Main impacts on biodiversity related to offshore wind parks

Negative impacts	Positive impacts
Collisions with birds and bats *Construction phase:* • Increased vessel traffic associated with surveying and installation activities creates the risk of collision with marine mammals, sea turtles, and fish (Bailey et al. 2014). *Operational phase:* • One of the major concerns for this phase are seabird mortality caused by collision with the moving turbine blades (Bailey et al. 2014, Birdlife International, 2003, Seys et al., 2001). Both for birds migrating through the area as well as for those that breed or forage in the vicinity. • Bats (migratory and non-migratory) regularly forage around the offshore wind turbines because of the accumulation of flying insects, increasing the risks to be killed (Ahlén, et al., 2007).	**No fishing zones (positive for marine biodiversity)** *Operational phase:* • Local species benefit from fisheries exclusion, both targeted species and non-targeted bycatch species (Bergström et al. 2014). • The exclusion also prevents bottom trawling (the dragging of nets on the sea floor) so benthic organisms benefit as well (Bergström et al. 2014). • Surrounding areas may also see an increase in species abundance (Bergström et al. 2014). • There may even be opportunities to combine offshore wind farms with open ocean aquaculture (Bailey et al. 2014).
Displacement and deviation of migratory routes of birds and bats (barrier effects) *Operational phase:* • Birds may fly around, rather than between, clusters of wind turbines , thereby increasing the energetic costs of flight or disrupting ecological links between feeding, roosting, breeding and moulting areas, and extending migration routes (Birdlife International, 2013) • One of the major concerns for this phase is seabird displacement from key habitats as a result of avoidance responses (Bailey et al. 2014, Birdlife International, 2003, Seys et al., 2001). These issues can affect birds migrating through the area as well as those that breed or forage in the vicinity.	**Artificial coral reefs/ marine reserves (positive for marine biodiversity)** *Operational phase:* • Windmills can produce habitat gain by acting as artificial reefs, thereby enhancing local species abundances and biodiversity (Bergström et al. 2014). • Fish are seasonally attracted to wind farms and seals potentially use them as foraging sites (Reubens et al. 2014), (Russell et al. 2014).
Increased noise levels *Construction phase:* • Sounds emitted during pile driving cause potential hearing damage, mask of calls, or displacement of animals (Bailey et al. 2014). • Sounds emitted during pile driving cause potential mortality and tissue damage in fish (Bergström et al. 2014). • Increased vessel traffic associated with surveying and installation activities creates the risk of noise disturbance to marine mammals, sea turtles, and fish (Bailey et al. 2014). *Operational phase:* • Acoustic disturbances from electricity generation and boat traffic for service and maintenance. The acoustic disturbances caused by the operation of the windmills are within the hearing range of fish and mammals, but underwater sound levels are unlikely to reach dangerous levels or mask acoustic communication of marine mammals (Bergström et al. 2014), (Bailey et al. 2014).	
Electromagnetic fields *Operational phase:* • Transmission cables transporting the generated electricity produce electromagnetic fields, which can affect cartilaginous fish, like sharks, which use electromagnetic signals in detecting prey (Bergström et al. 2014). • The electromagnetic fields could also disturb fish migration patterns by interfering with their capacity to orientate themselves in relation to Earth's magnetic field (Bergström et al. 2014).	
Non-indigenous species • Wind farms may introduce non-indigenous species that may potentially become invasive (Bergström et al. 2014, IUCN, 2010, Kerckhof et al., 2011).	

Main impacts on biodiversity related to offshore wind parks

Negative impacts	Positive impacts
Collisions with birds and bats • Wind farms kill millions of birds yearly around the world, and the high mortality of rare raptors is of particular concern. Wind farms on migration routes are particularly dangerous, and it is difficult to find a wind power site away from migration routes because there is no guarantee that migration routes will not vary (Birdlife International, 2013, Kikuchi, 2007). • Wind turbines can cause high fatality rates amongst bats (Kunz et al., 2007, Voigt et.al., 2012)	**Habitat enhancement** • Opportunities to undertake large-scale habitat restoration and enhancement. For example in the Whitelee wind farm, Scotland these include re-establishing 900 hectares of heathland and blanket bog through the clearance of conifer plantations, drain blocking and the continued management of a mosaic habitat to benefit black grouse (Birdlife International, 2013).
Displacement and deviation of migratory routes of birds and bats (barrier effects) • Wind turbines may act as barriers to movement of some bird species, with birds choosing to fly around the outside of clusters, instead of between turbines (Birdlife International, 2013). • Wit regard to birds being excluded from key areas due to barrier effects; the cumulative effects of large numbers of wind turbine installations may be considerable if birds are consequently displaced from preferred habitat or such detours become significant in terms of energy expenditure (Birdlife International, 2013).	**Positive land management** • Reduced inputs (fertiliser and pesticides); crop type/husbandry; sward height; restocking hedgerows; stocking densities (Birdlife International, 2013).
Habitat loss • Habitat loss from the turbine footprints is likely to be small, but can add up when associated road and grid infrastructure are included. This may be significant, particularly for large developments sited on sensitive or rare habitats, or where multiple projects affect the same habitat. Hydrological disruption, particularly on peatland substrates, may also risk wider indirect degradation (Birdlife International, 2013).	
Increased noise levels • Noise from (active) wind turbines may interfere with the lives of animals beneath the wind turbines. For example anti-predator behavior may change in the case of squirrels (Birdlife International, 2013, Kikuchi, 2007).	

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Annex E: qualitative analysis equities paper production and fashion

Qualitative analysis paper production

Summary

Main impacts related to paper packaging

- Land use effects: soil damage, habitat loss, changes in forest microclimate and food availability
- Habitat fragmentation
- Overexploitation
- Disturbance
- Indirect forest management impacts: spontaneous forest colonization and conversion, introduction of invasive species, increased rates of forest fire, wildlife and timber poaching

Use qualitative analysis

Adjustment of the ReCiPe footprint score if investing in products with (internationally) accepted ecolabels, like FSC or PEFC. For example by dividing the ReCiPe footprint by two.

General recommendations investment policies

- Exclusion unless or investing in 'best-in-class', based on best practice labels like FSC/PEFC
- Development of investment criteria addressing secondary effects of forestry practices

Recommendations ASN Bank

The investment in FSC forests makes that the ReCiPe footprint score should be adjusted. In addition to requiring (FSC) certification, ASN Bank could develop investment criteria addressing secondary impacts of forestry practices.

Explanation main impacts paper packaging

The main impacts on biodiversity resulting from the production of paper (packaging) are connected to land use for the production of trees. Both primary and secondary impacts of forest management activities exist. *Primary* impacts are the direct effects of road building, tree felling, log yarding, and log hauling. Such impacts include soil damage resulting in compaction and erosion, damage to the residual stand in selectively logged forests, changes in forest microclimate, changes in food availability, loss of habitat (e.g., trees used for nesting and roosting) and habitat fragmentation (e.g. wide logging roads impeding species movements and isolating sub-populations). *Secondary* impacts (indirect impacts), which can even be more serious, are mostly related to the improved access provided by logging roads. This access, if uncontrolled, can facilitate spontaneous forest colonization and conversion, invasion by secondary and non-forest species (by creating access corridors), as well as increased rates of forest fire along with wildlife and timber poaching (van Kuijk et al., 2009).

The majority of terrestrial biodiversity is found in forests. Forests also provide livelihoods to millions of people, many of whom are poor. The carbon stored in forests and the other ecosystem services they provide are of local, regional, and global concern.

The Food and Agriculture Organization (FAO, 2005) estimated that 13 million hectares of forest are lost each year to deforestation, which in itself has a significant impact on species. Similarly, biodiversity in degraded forests is also negatively impacted resulting in less resilient ecosystems that are less able to adapt to or recover from changing climate conditions.

If forest biodiversity is to be maintained and enhanced, human interactions with forest ecosystems need to be managed with careful attention to resource conservation and sustainability. Forest management may help to ensure that rare and endangered species are shielded from habitat destruction, poaching and other serious threats.

Production of paper from wood from FSC & PEFC certified forests will reduce the impact by land use and other forest related impact factors such as overexploitation, disturbance and introduction of invasive species. The main conclusion of a report by Tropenbos international (van Kuijk et al., 2009) about the effects of certified forest certification on biodiversity is that the forest management practices associated with forest certification[10] appear to benefit biodiversity in managed forests[11]. By using environmentally sensitive logging techniques, monitoring hunting activities, conserving nesting areas and fruit-bearing trees and adhering to laws that safeguard endangered species, FSC-certified forestry enterprises do a better job of protecting great apes and other mammals than noncertified ones (Rainforest Alliance, 2016). In some areas, using wood from FSC/PEFC certified forests may even be considered a positive contribution compared to non-forestry reserves.

See the box below for examples with regard to the contribution to biodiversity of FSC- and PEFC-certified forests.

Biodiversity contribution of FSC/PEFC certified forests compared to non-certified forests

Wildlife protection

- Great ape densities were found to be higher in FSC-certified forests (and those in the process of getting certified) than in other forestry concessions (WWF, 2009).
- In Cameroon, mammal density on FSC-certified enterprises or those in the process of getting certified was higher than in forestry businesses that were not pursuing certification (Dongmo et al., 2008).
- A study of seven timber companies in Gabon found that FSC-certified companies offered greater protection to wildlife, implementing 86 percent of best practices while noncertified companies implemented only 29 percent (Wildlife Conservation Society, 2010).
- In certified forestry concessions within Malaysia's FSC-certified Deramakot Forest Reserve, mammal populations were similar to those in protected areas, and these certified concessions had even greater numbers of some large mammals than surrounding reserves (Mannan et al., 2008).

Dead wood

Dead wood has an important function with regard to biodiversity. Twenty percent of the wildlife species that rely on dead wood are rare, vulnerable or endangered (WWF, 2004), and nearly all types of animals thrive in areas with abundant dead wood - a source of habitat as well as nutrients for soil health and forest regeneration.

- In Vermont, FSC-certified forests contained a significantly higher volume of standing and downed dead wood after logging than non-certified forests (Foster et al., 2006).
- PEFC also requires leaving retention trees in connection with regeneration fellings. These trees must never be taken out of the forest, but must be allowed to decay where they have stood. The total amount of additional decayed or decaying wood left in the forest since the PEFC system was introduced in Finland comes up to seven million cubic meters (Gaia Consulting, 2015).

Shifting attitudes towards wildlife protection

- In the Brazilian state of Acre, the adoption of FSC criteria by community forestry enterprises has not only created wildlife corridors and conserved ecologically sensitive areas; it has also helped to cultivate a culture of conservation and respect for wildlife among community members (Imaflora, 2009).
- PEFC has also affected attitudes. While know-how on, for example, the selection of retention trees and awareness of valuable, protected habitats have increased, attitudes towards protection are seen to become more positive (Gaia Consulting, 2015).

[10] Practices related to: reduced impact logging, protection of riparian buffers, protected areas, HCVF and corridors (between patches of undisturbed forests). Not considered in the study were hunting, chemical and waste management, human invasion, and indirect effects. The same holds for soil scarification, liana cutting, controlled burns, post-harvest liberation of potential crop trees and other silvicultural practices (van Kuijk et al., 2009).

[11] However, all conclusions drawn from the literature study done in this report can only be tentative as many difficulties and uncertainties exist. Only a handful of studies, all in a certified forest in Sabah, have directly assessed the effects of certified forest management on a number of plants and animals. They showed that populations of endangered animals increased (van Kuijk et al., 2009).

Methodological consequences

Adjustment for certification

Land use, the main pressure factor related to the production of paper (packaging), is already included in the ReCiPe methodology. The ReCiPe footprint score is however based on average impacts of the paper/wood sector. In case of investments in paper using FSC/PEFC certified wood, the ReCiPe score will be too high. Adjusting the ReCiPe score may be necessary, e.g. by dividing the footprint that follows from ReCiPe by two.

Secondary/indirect impacts on biodiversity from forestry

The ReCiPe results do not show information with regard to habitat fragmentation, overexploitation, disturbance (other important forest-related impacts) or indirect effects. Examples of these secondary (indirect) effects, that are mostly related to the improved access provided by roads, are introduction of invasive species, forest colonization and conversion, increased rates of forest fire and hunting.

To cover these secondary/indirect impacts, investment criteria would need to be developed since both FSC and PEFC pay little or no attention to these impacts.

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Qualitative analysis Fashion

Summary

Main impacts related to fashion
• Land use: need for vast spaces of land, extension of cultivation areas, monoculture crop systems, deforestation • Water use: large volumes used in cultivation and processing • Pollution: chemical use in production, processing and transport. Pollution in use and end- of-life phase • Climate change: energy use in production, processing and transport, GHG emissions (methane)
Use qualitative analysis
If the biodiversity footprint methodology would be limited to the midpoint indicators 'land use' and 'climate change', two important pressure factors in cotton production would not be included: water use and pollution (use of pesticides). Even if the influence of these two pressure factors would be of limited influence in the ReCiPe score, not addressing these (well known) pressure factors may give rise to reputational risks. This would call for the development of investment criteria covering these specific issues.
General recommendations investment policies
Options are: • Exclusion unless criteria/best in class: If a company sources cotton or cotton containing semi-fabrics, investment will be limited to companies sourcing certified cotton (organic, Better Cotton Initiative, GOTS)
Recommendations ASN Bank
Investing in best-in-class companies (exclusion uless) would fit ASN Bank's sustanaibility policies

Explanation main impacts fashion

Key impacts on biodiversity related to the production of fashion include land use, water use and chemical use. In the table below, key impacts on biodiversity of fashion are listed. This includes impacts of the production of raw materials, the processing of materials and the use and end-of life-phase (sources used to complete the table are listed at the end of this section).

Type of biodiversity impact	Explanation of impact
Land use	Production of natural materials (e.g. cotton, wool) • **Need for vast spaces of land** *Cotton:* Need for vast spaces of fertile land (in monoculture, exhausting the soil). Wool : need for vast spaces of land for keeping of sheep (while overgrazing may cause erosion) and production of feed. The quantity of fibre per land unit from sheep is low. • **Extension of cultivation areas**, impacting natural habitats and wild life • *Cotton:* Use of **monoculture crop systems**, reducing diversity of natural predators and increase need for pesticide use • *Viscose/rayon:* uncontrolled **deforestation** for the production of plant material may cause erosion and degradation of soils. However, for the cellulosic fibres, e.g. viscose, (marginal) land is needed but the yield of fibre per hectare of land is very positive. ***All recycled fibres and man-made fibres*** *score more positive onthe land use parameter since very little land is needed to produce these fibres. It is however important to note that abiotic depletion (depletion of oil) has not been taken into account for synthetic fibres.*
Water use	• **Consumption of large volumes of water during cultivation** of (organic and non-organic) cotton (causing overexploitation, erosion, drought and salinization). The actual impact would however highly depend on the water source; whether a field is irrigated or rain fed. • **Large amounts of water used in processing** , specifically causing an impact in water-stressed areas *Cotton:* Large amounts of water, inter alia as a result of rinsing after dyeing. *Wool:* Consuming large amounts of water for wool scouring • Viscose/ rayon: **Significant water used in wood pulp and fibre** manufacture ***All other fibre types*** *have a very low water use*

Pollution	• **Chemical use and other pollution in production** *Cotton:* use of substantial amounts of agrochemicals, causing pollution of land and water bodies by farm run-off due to precipitation, irrigation and drainage (impacts include eutrophication from phosphate and nitrate fertilizers). (Non- organic) cotton is one of the most polluting agricultural products in terms of the use of agrochemicals. *Polyester/ virgin nylon:* impacts like noise, light and pollution are linked to drilling for oil. *Polyester:* emissions of volatile organic substances and hazardous chemicals, potentially polluting waste water. • **Chemical use in wet processing** *Cotton:* very high use of chemicals may cause hazardous waste water (often discharged of without treatment) *Wool:* use of large amounts of chemicals for wool scouring to remove lanolin plus chemically intensive process to achieve washability, producing heavily polluted waste water, often discharged of without treatment and thus possibly polluting water streams and impacting aquatic species. • **Use of chemicals in transport** *Wool:* Use of chemicals (against moths and fungi) during transport. • **Pollution in use phase:** *Polyester/ nylon:* when washing polyester, it sheds of tiny plastic fibres that contribute to the plastic soup in the oceans. • **Pollution in end-of-life phase:** *Cotton:* heavy metals (accessories, remains from dyeing, etc.) may leach to the environment, potentially causing soil and groundwater water pollution. *Polyester:* products will not decompose. Disposed of products may end up in landfills (especially if western clothes are reused in non-western countries). Landfills waste valuable land and could pollute soil and groundwater, while the burning of garments may cause harmful air emissions.
Climate change	• **Energy use to grow/spin fiber** *Polyester and recycled polyester/ virgin nylon/viscose, rayon:* High fossil energy consumption when processing raw materials into fibres (refinery and polymerisation), contributing to climate change. *Overall, all man-made fibres (both synthetic and regenerated) score 'poorly' on energy input due to the high energy demands to turn these raw materials into fibres (refinery and polymerisation for synthetic fibres and pulping and spinning for regenerated).* • **Energy use in processing:** *Cotton/ wool:* fossil energy use (heating of water and running machinery for pre- treatment and dyeing of fabrics) • **Transport:** *e.g. Wool:* fossil energy use for transport • **GHG emissions:** ***Wool:*** high greenhouse gas emission (methane) due to digestive process/manure of the sheep. Also emission of methane when woollen garments decompose (end-of-life phase) *All **recycled** fibres score more positive on the GHG emissions as manufacturing products from recycled materials is less energy intensive and associated with fewer GHG emissions than making products from virgin materials.*

Methodological consequences

There are two situations in which the ReCiPe score may not be fully correct (too low or too high):

1. When the ReCiPe footprint calculation analysis is limited to the (dominant) midpoint indicators 'land use' and 'climate change', the pressure factors water use and pollution are excluded from the calculation. Considering the potential significance of these two pressure factors in case of cotton production in some production locations (e.g. in water scarce areas or close to high conservation value areas), the actual impact may be higher than indicated by the ReCiPe score. This can be addressed by addressing these potential impacts in investement criteria.

2. Impacts on biodiversity may be mitigated by companies by means of a 'materials approach', using:
   - o Recycled materials, e.g. recycled wool or recycled cotton are seen as some of the most sustainable fibres (based on six parameters: greenhouse gas emissions, human toxicity, eco-toxicity, energy, water and land use, MADE-BY, 2013). There are labels that certify the use of recycled fibres. An example of such a system is GRS (Control Union Global Recycle Standard) (MODINT, 2010-1).
   - o Organic materials, for example organic flax and organic hemp are seen as some of the most sustainable fibres (based on six parameters: greenhouse gas emissions, human toxicity, eco-toxicity, energy, water and land use, MADE-BY, 2013).
   - o Certified materials, such as organic, e.g. GOTS certified cotton.
   - o Innovative materials, for example tencel or more sustainable fibres from mammals, like alpaca. Alpaca fleece is seen as good alternative for cashmere as alpaca's do not cause land damage, are not raised in very fragile areas and consume a small amount of water. Moreover, their waste may be used as fertilizer (NRDC, 2011-1, 2012). Another example is wool from sheep grazing in areas where they have a landscape management function (e.g. preventing forest growth) (Schrijver, 2015).

   If the ReCiPe footprint score is based on the average impacts of the fashion sector and investments take place in best of class companies using sustainable materials, the ReCiPe score may be too high.

Best-in-class

An example of a fashion company that can be considered best-in-class with regard to their biodiversity impact is KOI (Kings of Indigo). The company sells denim, tops and accessories using innovative and sustainable production techniques where they can, such as:

- Use of recycled yarns as much as possible, waste and old garments. This process saves a lot of chemicals and water used to grow new cotton. Also all Kings of Indigo packaging is made from the best recycled material.
- Use of organic cotton helping to prevent pollution as the fields where this organic cotton is grown, are free of pesticides and fertilizers (that are used for conventional cotton growing).
- The organic cotton used is GOTS certified: tees and sweats are GOTS certified and the denim fabrics containing cotton are GOTS certified.
- Use of linen or tencel for denim fabrics that are not GOTS certified.
- No use any of the chemicals mentioned on the REACH list in their production.
- Use of low impact washes and natural dye techniques, where possible. No use of sandblasting.
- Sale and production as close to home as possible and preferably shipped by truck.

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Annex F: overview of clusters used for the qualitative analysis

The table below provides a list of the clusters that were used as a basis for the quick qualitative sector analysis (and that were developed as part of this project). It offers insight on what part of the ASN Bank's portfolio list these clusters are based.

Clusters:	Inludes (name(s) in portfolio ASN Bank)
Government Bonds	Government bonds
Mortgages, Housing corporations and Sustainable buildings	Home loans and other loans and advances to customers Mortgages: loan for a house Residential construction New buildings utilities: newly constructed office New buildings houses: new constructed house Renovation houses Construction (building) Housing corporations
Local governments	Local governments
Renewable energy	Renewable energy solar energy Wind op land Zonne-energie Mix bespaar: unknown (average of saved energy) Mix energie: mix of all energy forms
Health and welfare services	Health and welfare services
Water extraction and management (Water boards)	Water extraction and management (Waterschappen)
Rail transport	Rail transport Rail transport
Landscape (new nature)	Landscape: investments in Nationaal Groenfonds (new nature)
Heated network and geothermal heating	Warmtenet: heated network WKO/Geothermal heating
Food and beverage (and tobacco)	Not named, cluster developed within the project based on subsectors (NACE) and sectors (MSCI) in ASN Bank Portfolio list
Fashion and textiles	Not named, cluster developed within the project based on subsectors (NACE) and sectors (MSCI) in ASN Bank Portfolio list
Paper	Not named, cluster developed within the project based on subsectors (NACE) and sectors (MSCI) in ASN Bank Portfolio list
Chemicals and chemical products	Not named, cluster developed within the project based on subsectors (NACE) and sectors (MSCI) in ASN Bank Portfolio list
Electronics	Not named, cluster developed within the project based on subsectors (NACE) and sectors (MSCI) in ASN Bank Portfolio list
Furniture	Not named, cluster developed within the project based on subsectors (NACE) and sectors (MSCI) in ASN Bank Portfolio list
Metals and metal products, and rubber products	Not named, cluster developed within the project based on subsectors (NACE) and sectors (MSCI) in ASN Bank Portfolio list
Manufacture of other equipment	Not named, cluster developed within the project based on subsectors (NACE) and sectors (MSCI) in ASN Bank Portfolio list
Household goods and personal products	Not named, cluster developed within the project based on subsectors (NACE) and sectors (MSCI) in ASN Bank Portfolio list
Waste and water technologies	Not named, cluster developed within the project based on subsectors (NACE) and sectors (MSCI) in ASN Bank Portfolio list Bio digester
Printing	Not named, cluster developed within the project based on subsectors (NACE) and sectors (MSCI) in ASN Bank Portfolio list
Electricity (distribution)	Not named, cluster developed within the project based on subsectors (NACE) and sectors (MSCI) in ASN Bank Portfolio list
Other (commercial) services	Not named, cluster developed within the project based on subsectors (NACE) and sectors (MSCI) in ASN Bank Portfolio list

For the clusters that were developed based on the subsectors (NACE) and sectors (MSCI) in ASN Bank Portfolio list, the list below provides information on what specific (sub)sectors form part of the cluster. NB: Subsectors may be categorized in more than one cluster. The blue text indicates (that there are) other cluster(s) which the subsector forms part of.

Cluster	Subsector (NACE) in ASN Bank Portfolio list	Sector (MSCI) in ASN Bank Portfolio list
Food and beverage (and tobacco)	Manufacture of food products and beverages	Food, beverages & tobacco / Food, beverages & tobacco: Company-operated stores 78,9%; Licensed stores 9,7%; CPG, foodservice and other 11,4% / Food , beverage & tobacco: Portion packs 76,6%; Keurig brewer and acccessoires 17,5%; other 5,9% / / Food & staples retailing
	Production, processing and preserving of meat and meat products	Food, beverages & tobacco
	Retail sale of food, beverages and tobacco in specialized stores, Retail sale of textiles, Retail sale of footwear and leather goods, Retail sale of cosmetic and toilet articles	Retailing: Clothing, food, home and beauty: general merchandise (43%) & food (57%)
	Retail sale of food, beverages and tobacco in specialized stores, Wholesale of machinery, equipment and supplies, Agents involved in the sale of furniture, household goods, hardware and ironmongery	Food & staples retailing: Grocery trade Finland 44%; Grocery Trade Russia 1%; Kespro 9%; Building and Home improvement trade 25%; Furniture trade 2%; Sports trade 2%; Agricultural trade 4%; Car trade 9%; Machinery trade 3%
Fashion and textiles	Clothing, accessories, footwear, cosmetics and home textiles	Consumer durables & apparel
	Manufacture of textiles and textile products, Manufacture of footwear	Consumer durables & apparel: Clothing, footwear, homeware and accessories / Consumer durables & apparel: Retail (35%), wholesale (30%) and bonita (35%) / Consumer durables & apparel: Printwear (66%) & branded apparel (34%) / Consumer durables & apparel: Footwear (62%), apparel (31%), equipment (6%), Global Brand Divisions (1%)
	Manufacture of textiles and textile products, Manufacture of footwear, Manufacture of sports goods	Consumer durables & apparel: Winter sports equipment (28%), footwear (29%), apparal (24%), cycling (10%) & sports instruments (9%) / Consumer durables & apparel: Sports shoes (74%), sportswear (19%) & sports equipment (7%)
	Retail sale of food, beverages and tobacco in specialized stores, Retail sale of textiles, Retail sale of footwear and leather goods, Retail sale of cosmetic and toilet articles	Retailing: Clothing, food, home and beauty: general merchandise (43%) & food (57%)
	Printwear (66%) & branded apparel (34%)	Consumer durables & apparel
Paper	Manufacture of other articles of paper and paperboard n.e.c., Manufacture of plastic products	Materials: Foodservice Europe-Asia-Oceania 27%; North America 34%; Flexible Packaging 28%; Molded Fiber 11%
	Manufacture of pulp, paper and paper products; publishing and printing	Materials
	Paper & packaging	Waste technologies & resource management
	Retail sale of books, newspapers and stationery, Retail sale of furniture, lighting equipment and household articles n.e.c., Retail sale of electrical household appliances and radio and television goods	Retailing: Core office supplies 25,6%; Ink and toner 20%; Business technology 14,3%; Paper 9,2%; Facilities and breakroom 10%; Computers and mobility 6,3%; Services 8,6%; Office furniture 6% / Retailing: Supplies 47,2%; Technology 38%; Furniture and other 14,8%
Chemicals and chemical products	Manufacture of chemicals and chemical products	Materials
	Manufacture of chemicals, chemical products and man-made fibres	Pharmaceutical biotechnology & life sciences / Materials
	Manufacture of pharmaceuticals, medicinal chemicals and botanical products	Pharmaceutical biotechnology & life sciences / Materials
	Manufacture of pharmaceuticals, medicinal chemicals and botanical products, Manufacture of medical and surgical equipment and orthopaedic appliances	Pharmaceutical biotechnology & life sciences
	Manufacture of plastics in primary forms	Alternative energy & energy efficiency / Materials
	Manufacture of other articles of paper and paperboard n.e.c., Manufacture of plastic products	Materials: Foodservice Europe-Asia-Oceania 27%; North America 34%; Flexible Packaging 28%; Molded Fiber 11%

Cluster	Subsector (NACE) in ASN Bank Portfolio list	Sector (MSCI) in ASN Bank Portfolio list
Electronics	Manufacture of electric domestic appliances	Consumer durables & apparel
	Manufacture of electrical equipment, Manufacture of lighting equipment and electric lamps, Manufacture of medical and surgical equipment and orthopaedic appliances	Capital goods
	Manufacture of electronic valves and tubes and other electronic components	Alternative energy & energy efficiency
	Manufacture of lighting equipment and electric lamps	Electronic equipment, instruments & components
	Manufacture of radio, television and communication equipment and apparatus.	Consumer durables & apparel
	Manufacture of wire products	Capital goods / Automobiles & components
	Retail sale of electrical household appliances and radio and television goods	Retailing
	Retail sale of books, newspapers and stationery, Retail sale of furniture, lighting equipment and household articles n.e.c., Retail sale of electrical household appliances and radio and television goods	Retailing: Core office supplies 25,6%; Ink and toner 20%; Business technology 14,3%; Paper 9,2%; Facilities and breakroom 10%; Computers and mobility 6,3%; Services 8,6%; Office furniture 6% / Retailing: Supplies 47,2%; Technology 38%; Furniture and other 14,8%
	Manufacture of non-refractory ceramic goods other than for construction purposes; manufacture of refractory ceramic products, Manufacture of electronic valves and tubes and other electronic components	Electronic equipment, instruments & components
	Retail sale of furniture, lighting equipment and household articles n.e.c.	Retailing
	Manufacture of pumps and compressors	Alternative energy & energy efficiency / Electronic equipment, instruments & components
	Printing and service activities related to printing, Manufacture of electrical equipment, Packaging activities	Commercial services & supplies: Information and Communication 47,6%; Lifestyle and industrial supplies 32,6%; Electronics 15,7%; Beverages 4,1%
	No info	Technology hardware & equipment
	No info	Automobiles & components
	No info	Capital goods
Furniture	Manufacture of furniture	Commercial services & supplies
	Retail sale of books, newspapers and stationery, Retail sale of furniture, lighting equipment and household articles n.e.c., Retail sale of electrical household appliances and radio and television goods	Retailing: Core office supplies 25,6%; Ink and toner 20%; Business technology 14,3%; Paper 9,2%; Facilities and breakroom 10%; Computers and mobility 6,3%; Services 8,6%; Office furniture 6% / Retailing: Supplies 47,2%; Technology 38%; Furniture and other 14,8%
	Retail sale of furniture, lighting equipment and household articles n.e.c.	Retailing
	Retail sale of food, beverages and tobacco in specialized stores, Wholesale of machinery, equipment and supplies, Agents involved in the sale of furniture, household goods, hardware and ironmongery	Food & staples retailing: Grocery trade Finland 44%; Grocery Trade Russia 1%; Kespro 9%; Building and Home improvement trade 25%; Furniture trade 2%; Sports trade 2%; Agricultural trade 4%; Car trade 9%; Machinery trade 3%
Metals and metal products, and rubber products	Manufacture of other rubber products, Manufacture of basic metals and fabricated metal products	Capital goods
	Manufacture of steel drums and similar containers	Materials
	Retail sale of food, beverages and tobacco in specialized stores, Wholesale of machinery, equipment and supplies, Agents involved in the sale of furniture, household goods, hardware and ironmongery	Food & staples retailing: Grocery trade Finland 44%; Grocery Trade Russia 1%; Kespro 9%; Building and Home improvement trade 25%; Furniture trade 2%; Sports trade 2%; Agricultural trade 4%; Car trade 9%; Machinery trade 3%
Manufacture of other equipment	Manufacture of machinery and equipment	Capital goods
	Manufacture of medical and surgical equipment and orthopaedic appliances	Health care equipment & services
	Manufacture of medical, precision and optical instruments, watches and clocks	Technology hardware & equipment

Cluster	Subsector (NACE) in ASN Bank Portfolio list	Sector (MSCI) in ASN Bank Portfolio list
	Manufacture of optical instruments and photographic equipment	Health care equipment & services
	Manufacture of central heating radiators and boilers	Alternative energy & energy efficiency / Consumer durables & apparel / Electronic equipment, instruments & components / Commercial services & supplies
	Manufacture of ceramic insulators and insulating fittings	Technology hardware & equipment
	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment, Manufacture of industrial process control equipment	Water technologies & other pollution control / Alternative energy & energy efficiency
	Manufacture of glass fibres	Alternative energy & energy efficiency
	Manufacture of non-refractory ceramic goods other than for construction purposes; manufacture of refractory ceramic products, Manufacture of electronic valves and tubes and other electronic components	Electronic equipment, instruments & components
	Retail sale of food, beverages and tobacco in specialized stores, Wholesale of machinery, equipment and supplies, Agents involved in the sale of furniture, household goods, hardware and ironmongery	Food & staples retailing: Grocery trade Finland 44%; Grocery Trade Russia 1%; Kespro 9%; Building and Home improvement trade 25%; Furniture trade 2%; Sports trade 2%; Agricultural trade 4%; Car trade 9%; Machinery trade 3%
Construction (building)	General construction of buildings and civil engineering works	Water technologies & other pollution control
	Manufacture of concrete products for construction purposes	Alternative energy & energy efficiency
	Renting of construction and civil engineering machinery and equipment	Commercial services & supplies
	Real estate, renting and business activities	Home construction / Real estate
Household goods and personal products	Manufacture of household and sanitary goods and of toilet requisites	Household & personal products / Capital goods / Water technologies & other pollution control / Consumer durable & appearal
	Manufacture of perfumes and toilet preparations	Household & personal products
	Repair of personal and household goods	Commercial services & supplies
	Retail sale of food, beverages and tobacco in specialized stores, Retail sale of textiles, Retail sale of footwear and leather goods, Retail sale of cosmetic and toilet articles	Retailing: Clothing, food, home and beauty: general merchandise (43%) & food (57%)
	Retail sale of furniture, lighting equipment and household articles n.e.c.	Retailing
	Clothing, accessories, footwear, cosmetics and home textiles	Consumer durables & apparel
	Retail sale of books, newspapers and stationery, Retail sale of furniture, lighting equipment and household articles n.e.c., Retail sale of electrical household appliances and radio and television goods	Retailing: Core office supplies 25,6%; Ink and toner 20%; Business technology 14,3%; Paper 9,2%; Facilities and breakroom 10%; Computers and mobility 6,3%; Services 8,6%; Office furniture 6% / Retailing: Supplies 47,2%; Technology 38%; Furniture and other 14,8%
	Retail sale of food, beverages and tobacco in specialized stores, Wholesale of machinery, equipment and supplies, Agents involved in the sale of furniture, household goods, hardware and ironmongery	Food & staples retailing: Grocery trade Finland 44%; Grocery Trade Russia 1%; Kespro 9%; Building and Home improvement trade 25%; Furniture trade 2%; Sports trade 2%; Agricultural trade 4%; Car trade 9%; Machinery trade 3%
	No info	Household & personal products
Rail transport	Transport via railways	Transportation
	Manufacture of railway and tramway locomotives and rolling stock	Capital goods
Waste and water technologies	Sewage and refuse disposal, sanitation and similar activities	Water technologies & other pollution control
	Recycling (88%), Sewage and refuse disposal, sanitation and similar activities	Waste technologies & resource management
	Recycling, Sewage and refuse disposal, sanitation and similar activities	Waste technologies & resource management
	No info	Waste technologies & resource manageent

Cluster	Subsector (NACE) in ASN Bank Portfolio list	Sector (MSCI) in ASN Bank Portfolio list
	Plumbing, Other building installation	Water technologies & other pollution control
	NB: Collection, purification and distribution of water is part of the cluster 'water extraction and management (water boards)':	Water technologies & other pollution control
Printing	Printing and service activities related to printing	Technology hardware & equipment
	Printing and service activities related to printing, Manufacture of electrical equipment, Packaging activities	Commercial services & supplies: Information and Communication 47,6%; Lifestyle and industrial supplies 32,6%; Electronics 15,7%; Beverages 4,1%
	Printwear (66%) & branded apparel (34%)	Consumer durables & apparel
	Publishing, printing and reproduction of recorded media	Media / Media: Paid Models 51,4%; Marketing Models 26,1%; Classified Ad Models 16,9%; Services/Holding 5,6%
Electricity (distribution)	Manufacture of electricity distribution and control apparatus	Utilities
	Manufacture of electricity distribution and control apparatus (distribution of electricity, gas and water)	Alternative energy & energy efficiency
	Production and distribution of electricity (Renewable energy)	Utilities / Alternative energy & energy efficiency
	No info	Alternative energy & energy efficiency
Other (commercial) services	Advertising	Media / Food & staples retailing
	Business and management consultancy activities	Waste technologies & resource management
	Funeral and related activities	Commercial services & supplies
	Information and Communication 59,6%; Material Solutions 22,3%; Living Environment 18,2%	Commercial services & supplies
	Labour recruitment and provision of personnel	Commercial services & supplies
	Software consultancy and supply	Commercial services & supplies
	Publishing of books, Education	Commercial services & supplies
	Motion picture and video production	Consumer durables & apparel
	Photographic activities	Commercial services & supplies
	No info	Telecommunication services
	Research and experimental development on natural sciences and engineering	Technology hardware & equipment
	Licensing, Management & Business Development; Manufacturing; R&D	Materials
	Printing and service activities related to printing, Manufacture of electrical equipment, Packaging activities	Commercial services & supplies: Information and Communication 47,6%; Lifestyle and industrial supplies 32,6%; Electronics 15,7%; Beverages 4,1%

Annex G: qualitative screening clusters of sectors

The matrix below provides an overview of the linkages between (sector) clusters and key drivers of biodiversity loss. It also gives insight in the action perspectives that may influence these key drivers of biodiversity loss. This overview is based on a quick screening, not on an in depth assessment.
The clusters that were used have been developed based on ASN Bank's portfolio list. Please see Annex F for insight in what specific (sub)sectors (or names in ASN Bank's portfolio list) form part of each cluster.

Explanation of colours used (no color/white = row and column titles and action perspectives; not a risk category):

Neutral risk (no significant impact risk of the cluster on the driver)
Medium risk
High risk
Driver is not relevant for the cluster
Positive impact of the cluster on the driver

CLUSTER	LAND CONVERSION	POLLUTION	CLIMATE CHANGE	OVEREXPLOITATION (incl. biotic and water resources)	INTRODUCTION INVASIVE SPECIES	DISTURBANCE (incl. habitat fragmentation)	ACTION PERSPECTIVES INFLUENCING SPECIFIC DRIVERS
Government Bonds	*Biodiversity impacts related to government bonds are diverse; all types of impacts are possible (impacts caused by land use, climate change, pollution, overexploitation, invasive species, disturbance).*						
Mortgages, Housing corporations and Sustainable buildings	• Production of renewable raw materials, like wood. • Production of non- renewable raw materials like metals. • Land use by the building itself.	Emissions of hazardous substances in construction, during production, use and waste	• Energy consumption during production. • Energy consumption during use	Use of non- sustainable (tropical) wood as construction material	• Introduction of non- native species in forestry • Introduction of GMOs (forestry)	• Noise and physical disturbance of building process. • Fragmentation by the building itself	• Use of (FSC/PEFC) certified wood reduces impacts on overexploitation and introduction of invasive species • Providing a green environment (green roofs/walls), providing nest space and urban habitats (construction measures) and creating a green/blue infrastructure (spatial planning measures) reduce impacts on disturbance and land use/ conversion • Use of pro-biodiversity (building) materials reduces impacts on land conversion

CLUSTER	LAND CONVERSION	POLLUTION	CLIMATE CHANGE	OVEREXPLOITATION (incl. biotic and water resources)	INTRODUCTION INVASIVE SPECIES	DISTURBANCE (incl. habitat fragmentation)	ACTION PERSPECTIVES INFLUENCING SPECIFIC DRIVERS
Local governments	*Biodiversity impacts related to local governments are diverse; all types of impacts are possible (impacts caused by land use, climate change, pollution, overexploitation, invasive species, disturbance).*						
Renewable energy - Wind energy	Habitat creation, offshore: artificial coral reefs/marine reserves and no- fishing zones and onshore: habitat enhancement (vs habitat loss)	• Emissions of hazardous substances during production of wind mills • Emissions of hazardous substances in the waste phase.	Positive compared to use of fossil fuels		Offshore: introduction of invasive species	• Noise • Collisions and displacement of birds and bats • Offshore: electromagnetic fields	Terrestrial wind parcs: large-scale habitat restoration and enhancement mitigates impacts through land conversion (extraction of raw materials)
	Production of non- renewable raw materials, like metals.						
Renewable energy - solar energy	• Production of non- renewable raw materials, like metals • Land use of solar • parks	• Emissions of hazardous substances during production of solar panels • Emissions of hazardous substances in the waste phase	Positive compared to use of fossil fuels				
Renewable energy - Mix energy: mix of all energy forms	• Production of biomass for biofuels (electricity production) • Gas exploration	Emissions to air during gas use and electricity production	GHG emissions from the use of fossil fuels	Only potentially in case of biomass production: Overexploitation of water resources for biomass production.	Only potentially in case of biomass production: Introduction of GMOs (e.g. soy)	• Industry related noise and habitat fragmentation • Agricultural related habitat fragmentation (biomass production)	• (Ecologically) sustainable biomass production may reduce impacts by land conversion, overexploitation and introduction of invasive species
Health and welfare services	*With regard to the building of health and welfare services buildings, the impacts and action perspectives with regard to (sustainable) building apply*	Emissions of hazardous substances to water (medicines) during use and disposal					
Water extraction and management (Water boards) - *including purification (wastewater treatment) and distribution of water*	Habitat creation and habitat enhancement	Wastewater treatment: emissions of hazardous substances during operation and waste phase	Wastewater treatment: energy consumption during operation	Overexploitation of water resources			

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Rail transport	• Production of non- renewable raw materials, like metals. • Production of renewable • raw materials, like cotton, leather, and rubber. • Oil extraction for the production of polyester, plastics, etc.	• Emissions of hazardous substances during production. • Emissions of hazardous substances in wastewater during maintenance. • Emissions of hazardous substances in the waste phase. • Air emissions during production of electricity	• Energy consumption of production. • Energy consumption of use.	• Use of non- sustainable (tropical) wood for railway construction • Overexploitation of water resources (rubber or cotton production)	• Risk of spread invasive species of transport • Introduction of non- native species/ GMOS's in forestry (wood production)	• Noise (production and use) • Habitat • fragmentation	• Use of recycled materials reduces impacts on land conversion • Use of (FSC/PEFC) certified wood reduces impacts on land conversion, overexploitation and introduction of invasive species
Landscape (new nature)	Habitat creation and habitat enhancement					Preventing habitat fragmentation	
Heated network and geothermal heating			Positive effect compared to conventional energy use				
Food and beverage (and tobacco)	Production of food crops (agriculture)	• Use of agro- chemicals in agriculture. • Wastewater discharge during food production	Energy consumption during food production	• Overexploitation • of fish. • Overexploitation of water resources	• Introduction of non- native species in aquaculture and agriculture. • Introduction of GMOs.	• Agricultural /horticultural light pollution and habitat fragmentation • Industry related noise and habitat fragmentation • Fisheries' physical disturbance of seabeds	• Organic production reduces impacts on land conversion and introduction of invasive species (GMO's) • Certified products, for example EU ecolabel certified, Rainforest Alliance or UTZ certified products, may reduce impacts on all key drivers of biodiversity loss • Certified fishery products may reduce impacts on over- exploitation and disturbance (e.g. MSC certified fish)

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Fashion and textiles	• Production of cotton and other natural fibres. • Oil extraction for the production of polyester, etc.	• Emissions of hazardous substances during production of raw materials (especially cotton). • Emissions of hazardous substances during dying and finishing. • Generation of hazardous waste. • Contribution to plastic soup in use and waste phase	• Energy consumption during production of materials (e.g. wet processing). • Energy production during Cut Make Trim phase. Energy production during use phase (washing, drying).	Overexploitation of water resources in cotton production	Introduction of GMOs (cotton)	• Agricultural light pollution and habitat fragmentation • Industry related noise and habitat fragmentation	• Organic production (for example GOTS- certified cotton) impacts reduces impacts on land conversion, pollution and introduction of invasive species (GMO's) • The use of recycled materials, e.g. recycled wool or recycled cotton, reduces impacts on all key drivers of biodiversity loss (certified recycled materials exist, such as the Global Recycle Standard, GRS) • Attention for the life span of products and recycling potential may reduce impacts on all key drivers of biodiversity loss
Paper	Production of wood for pulp and paper production	• Emissions of hazardous substances during production. • Emissions of hazardous substances during waste phase.	Energy consumption during production	• Use of non-sustainable • (tropical) wood. • Overexploitation of water resources in production of pulp/ paper.	• Introduction of non- native species in forestry • Introduction of GMOs (forestry)	• Forestry related noise and habitat fragmentation • Physical disturbance of flora	• Use of (FSC/PEFC) certified wood reduces impacts on land use, overexploitation, introduction of invasive species and disturbance • Use of recycled paper reduces impacts on all key drivers of biodiversity loss
Chemicals and chemical products	• Mining operations for the production of non-renewable raw materials, like sulfur, phosphate • Oil extraction for the production of materials	• Emission of hazardous substances during production of the chemicals/ chemical products • Emission of hazardous substances to soil and water in the waste phase.	Energy consumption during production	Pharmaceuticals: overexploitation of biotic resources (bioprospecting, using biotic resources as a basis to produce synthetic materials)		• Industry related noise and habitat fragmentation • Pharmaceuticals: physical disturbance of flora (bioprospecting)	Pharmaceuticals: Attention for Access and Benefit Sharing (ABS)

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Electronics	• Mining operations for the production of metals used in electronics • Oil extraction for the production of plastics used • in electronics	Emissions of heavy metals and hazardous substances during production and waste disposal (e- waste)	Energy consumption during production and use			Industry related noise and habitat fragmentation	• Use of recycled materials reduces impacts on all key drivers of biodiversity loss • Attention for the life span of products and recycling potential may reduce impacts on all key drivers of biodiversity loss • Attention for energy use in the use phase reduces impacts on climate change
Furniture	• Production of renewable raw materials, like wood, cotton, wool. • Production of non- renewable raw materials like metals, glass.	• Emission of hazardous substances during production of the materials used. • Emission of hazardous substances to air and water during furniture production. • Emission of hazardous substances to soil and water in the waste phase.	• Energy consumption of the production of raw materials. • Energy consumption of furniture production	Use of non- sustainable (tropical) wood	• Introduction of non- native species in forestry • Introduction of GMOs (forestry, cotton)	• Forestry related noise and habitat fragmentation • Physical disturbance of flora (forestry and agriculture; e.g. sheep farming) • Industry related noise and habitat fragmentation	• Use of (FSC/PEFC) certified wood reduces impacts on overexploitation and introduction of invasive species • Use of recycled materials reduces impacts on all key drivers of biodiversity loss • Attention for the life span of products and recycling potential may reduce impacts on all key drivers of biodiversity loss • Use of certified furniture (e.g. EU Ecolabel) or certified materials (e.g. GOTS certified cotton) may reduce impacts on all key drivers of biodiversity loss
Metals and metal products, and rubber products	• Mining operations for the production of metals • Production of natural rubber • Oil extraction for production of synthetic rubber	Emissions of hazardous substances during production and waste disposal	Energy consumption during production	Overexploitation of water resources (natural rubber production)		• Agricultural habitat fragmentation (natural rubber prodcution) • Industry related noise and habitat fragmentation	• Use of recycled materials reduces impacts on all key drivers of biodiversity loss • Attention for the life span of products and recycling potential may reduce impacts on all key drivers of biodiversity loss

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Manufacture of other equipment	Production of non- renewable raw materials, like steel	• Emission of hazardous substances during production, including waste water, and waste disposal • Emissions and spills during use	• Energy consumption • during use. • Energy consumption during production.			Industry related noise and habitat fragmentation	• Use of recycled materials reduces impacts on all key drivers of biodiversity loss • Attention for the life span of products and recycling potential may reduce impacts on all key drivers of biodiversity loss • Attention for energy use in the use phase reduces impacts on climate change
Household goods and personal products *- including sanitary goods and toilet requisites, cosmetic articles, perfumes and household products*	• Production of renewable raw materials, like plants (agriculture) • Oil extraction for the production of (micro) plastics, etc.	• Emission of hazardous substances during production • Emission of hazardous substances to soil and water in the waste phase. • Contribution to plastic soup in use and waste phase	Energy consumption during production	Overexploitation of resources (bioprospecting)		• Industry related noise and habitat fragmentation • Agricultural /horticultural light pollution and habitat fragmentation • Physical disturbance of flora (bioprospecting)	• Organic production reduces impacts on land conversion and introduction of invasive species (GMO's) • Certified products, for example EU ecolabel certified products, may reduce impacts on pollution and climate change.
Waste and water technologies *- including recycling, sewage and refuse disposal, sanitation and similar activities, plumbing and other building installations, including bio digester*	• Mining of metals, minerals for the production of raw materials for pipes, • Oil extraction for the production of plastics • (raw materials for pipes)	Emission of hazardous substances during production, operation and waste processing (e.g. emissions of plastic incineration)	Energy consumption during operation and production of pipes			• Noise and habitat fragmentation caused by operational activities	
			Energy generation from waste streams (e.g. biogass)				

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Printing	• Oil extraction for the production of plastics, for toner cartridge production • Mining of metals for toner production	Emissions of hazardous substances during production, use and disposal of toner cartridge/ink	• Energy consumption during production of toner cartridge/ink • Energy consumption during use of printers			Industry related noise and habitat fragmentation	• Attention for the recycling potential of print work may reduce impacts on all relevant key drivers of biodiversity loss • Use of recycled toner cartridges reduces impacts on all key drivers of biodiversity loss • Attention for energy use in the use phase reduces impacts on climate change
Electricity (distribution)	Raw materials for production of cable production and production of highwire installations (e.g. rubber, metals)	Emissions to air during production of cables, highwire installations etc.	• Energy consumption during production of cables etc. • Energy consumption during development of distribution infrastructure			Industry related noise (infrastructure development)	Distribution infrastructure: creation of habitat
Other (commercial) services	*Biodiversity impacts related to this highly diverse cluster are also diverse; all types of impacts are possible (impacts caused by land use, climate change, pollution, overexploitation, invasive species, disturbance).*						

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