Methods for analyses in Indebted to nature

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1 Loss of ecosystem services

This method is based on the ENCORE database of the Natural Capital Finance Alliance.[1] This database details the dependencies of 86 business processes on 21 ecosystem services and eight types of natural capital. The classification of ecosystem services is itself based on the internationally widely used CICES classification. The dependence of each business process on an ecosystem service has a materiality rating from very low to very high. This rating is a function of the loss of functionality for the business process and the accompanying financial losses if the ecosystem service is lost. Only ecosystem services with high or very high dependence are included in the current analysis.

The business processes from the ENCORE database were first linked to business sectors in the two-digit NACE REV 2 classification. As the database is based on the GICS classification, this linking was done manually. This NACE-ENCORE link simulates the original link to GICS and replaces it. In both classifications, a number of business processes are assigned to individual sectors. For example, in agriculture a distinction is made between the business processes of rain-fed and irrigated crop cultivation. In these cases, a weighting factor was allocated in proportion to the number of business processes within that sector. This means it was assumed that the various business processes are proportional in scope within the sector in question.

The exposure of the financial sector to the two-digit NACE[2] REV 2 sectors were determined on the basis of the statistics of holdings of equity and bond investments by pension funds, insurers and banks, and on the basis of a database for business loans by banks. Using the ENCORE database, the exposure of financial institutions to the various ecosystem services was subsequently determined in two ways. The first method is based on an unweighted allocation of exposures to each ecosystem service with high or very high dependence. For a business process with high or very high dependence on, for example, the groundwater supply and pollination, one euro is allocated to the groundwater supply and one to pollination for every euro invested in that business process. Using this method, the exposure of financial institutions to individual ecosystem services, such as the groundwater supply, can be determined. However, in this case the various ecosystem services cannot be added up, as business processes are often dependent on several ecosystem services.

1 UNEP-WCMC and NCFA (2018)
2 Nomenclature statistique des activités économiques dans la Communauté européenne is the sector-classification system used in European financial statistics.

The second method is based on an allocation of exposures to ecosystem services with high or very high dependence, weighted according to the number of ecosystem services. For a business process with high or very high dependence on, for example, the groundwater supply and pollination, one euro is allocated to the groundwater supply and one to pollination for two euros invested in that business process. With this method, the dependence of the whole portfolio of financial institutions on *one or more* ecosystem services can be determined. This is because, where business processes have multiple dependencies, exposure is proportionally distributed over these dependencies before being added up.

2 Loss of animal pollination

The method for this analysis was inspired by Bastein, Rietveld and Van Zyl (2014) (2014); see Appendix C Structure of linking matrix. In this analysis, an estimation was made of the relevance of 64 raw materials that are crucial for the Dutch economy. DNB (2019) subsequently described the dependence of the Dutch financial sector on these raw materials. In the analysis of animal pollination, we looked at the exposure of the Dutch financial sector to crops that depend on animal pollination. For this purpose we used the method from Bastein et al. (2014) and DNB (2019).

Based on Klein et al. (2007), it was determined for 107 crops whether and to what extent the crop yield is dependent on animal pollination. We selected the 90 crops with a dependence greater than 0.[3]

Next, for each crop, the HS[4] product codes were assigned in which such a crop occurs. Of the above mentioned 90 crops we were able to couple 55 to HS codes.
Each HS code represents a product group. With the help of linking matrices (HS-CPA[5] and CPA-NACE), these HS codes were linked to two-digit NACE REV 2 (Bastein et al., 2014). In many cases, there are multiple HS codes in one two-digit NACE REV 2 code. To determine the relative importance of HS codes for the relevant two-digit NACE REV 2 sector, we used the BACI (Base pour l'Analyse du Commerce International) dataset of the World Trade Database. The importance of a specific HS product group was allocated to a sector in proportion to the commercial value of the HS product group relative to the total commercial value of all HS product groups in the two-digit NACE REV 2 sector.

To determine the exposure of the Dutch financial sector, for pension funds, insurers and banks we look at statistics of equity and bond holdings in NACE REV 2 sectors in 2019-IV. For the amount of EUR 1,550 billion, it is known in which NACE REV 2 sector the company operates, in which Dutch financial institutions have equity or bond holdings. For the Dutch banks, we additionally look at EUR 606 billion in loans as of 2017-IV for which the NACE REV 2 sector is available.

To calculate total exposure, we use the following formula:

$$\textit{Exposure Dutch Financial Sector} = \sum_i \sum_j \sum_k \textit{BACI relative value}_j * \textit{ExposureNACE}_k * \mathbf{1}_{\{j \in k\}}$$

where *i* is one of the 55 crops which, according to Klein et al. (2007), is dependent on animal pollination, and can be coupled to a HS code; *BACI relative value*$_j$ is the share of the HS code *j* in the NACE REV 2 two-digit sector *k* to which the Dutch financial sector has an exposure of *ExposureNACE*$_k$. The indicator function equals 1 if HS code *j* occurs in NACE two-digit sector *k*.

3 A dependence of 0 means that the yield does not depend on animal pollination.
4 Harmonized Commodity Description and Coding Systems; see https://unstats.un.org/unsd/tradekb/Knowledge-base/50018/Harmonized-Commodity-Description-and-Coding-Systems-HS.
5 Classification of Products by Activity; see https://ec.europa.eu/eurostat/web/cpa/cpa-2008.

3 The biodiversity footprint of the financial sector

We determine the biodiversity footprint of the exposure of Dutch financial institutions. The biodiversity footprint means the loss of biodiversity. We define this biodiversity loss as the total historical loss relative to the pristine situation as a consequence of land use, and future biodiversity loss as a consequence of climate change caused by current greenhouse gas emissions. For this, we use the MSA indicator developed by the PBL Netherlands Environmental Assessment Agency[6], which shows the degree of naturalness of an ecosystem. This indicator is determined on the basis of a comparison between the existing species and population sizes in undisturbed systems and those in systems influenced by humans (Alkemade et al., 2006 and Schipper et al., 2020).

Financial institutions invest in, or lend to, companies that have an impact on the natural environment. To determine the footprint of the Dutch financial institutions, we calculate the footprint of 8,022 companies in which institutions invest. We determine the biodiversity footprint by means of land use and greenhouse gas emissions. In addition to the impact of companies' operations, we also consider the impact made through companies' supply chains.

We use the method of Wilting and Van Oorschot (2017). While they calculated the footprint of sectors of the Dutch economy, we look in particular at the footprint of large companies in the portfolio of Dutch financial institutions. These institutions operate internationally, so we do not restrict ourselves to the Dutch perspective, but instead adopt a global outlook.

3.1 Linking sector classifications

Wilting and Van Oorschot (2017) uses the WIOD sector classification, based on Timmer (2012). In order to create the link to the companies that Dutch financial institutions invest in, this WIOD sector classification has to be linked to the NACE REV 2 classification. This process involves three steps:

1. NACE REV 2 -> NACE REV 1.1
2. NACE REV 1.1 -> NACE REV 1
3. NACE REV 1 -> WIOD

We discuss each step below.

Re 1) A correspondence table for this can be found on the database website of Eurostat, Ramon: https://ec.europa.eu/eurostat/ramon/relations/index.cfm?TargetUrl=LST_LINK&StrNomRelCode=NACE REV. 2 - NACE REV. 1.1&StrLanguageCode=EN

Re 2) A correspondence table can be found for this on the database website of Eurostat, Ramon: http://ec.europa.eu/eurostat/ramon/other_documents/nace/NACE_Rev_1_NACE_Rev_1_1.zip. In creating this link, we encountered the following issues:

- Multiple NACE 1.1 codes that correspond to one NACE 1 code. This means that one old category has been split into several new categories. In that

6 See https://www.clo.nl/indicatoren/nl1440-ontwikkeling-biodiversiteit-msa.

case, each NACE 1.1 code was given the same NACE 1 code.

- Several NACE 1 codes that correspond to one NACE 1.1 code.
  a. If this happens and all two-digit NACE 1 codes are the same as the two-digit NACE 1.1 code, then the NACE 1.1 is allocated to this two-digit NACE 1 code. This is sufficient, because the final analysis is conducted at the NACE 1 two-digit level.
  – If a) is not the case, or if one NACE 1.1 four-digit code has different NACE 1 two-digit values, then we allocate it proportionally. For example: NACE 1.1 code 28.51 has two NACE 1 codes: 28.51 and 36.22. In that case we allocate 50% of NACE 1.1 code 28.51 to NACE 1 code 28 and 50% to NACE 1 code 36.
- New additions in NACE 1.1 at the NACE 1.1 four-digit level are given the same code in NACE 1 as in NACE 1.1.
- In NACE 1.1, 96 and 97 have been added as new categories. As these concern activities of households, these codes have been added to NACE 1 category 95: Private households with employed persons.
- Filling of aerosols, NACE 1 74.82, is no longer specified separately in NACE 2, but has been incorporated into Section D. This has been deleted.

Re 3) Page 70 of Timmer (2012) provides a table with the correspondence between WIOD and NACE REV 1. This classification is 1-to-1, so no problems arise.

After the link has been made between the correspondence tables from steps 1) and 2), various cases arise in which one NACE 2 four-digit code has multiple NACE 1 four-digit values. There are two cases:

- If all the different NACE 1 four-digit codes have the same NACE 1 two-digit value, we retain 1 of the NACE 1 four-digit codes. This is done because the final analysis is conducted at the NACE 1 two-digit level. For example: NACE 2 code 01.11 has two NACE 1 codes: 01.11 and 01.12. We allocate these to NACE 1 level 01.
- If different NACE 1 four-digit codes have different NACE 1 two-digit values, then we allocate them proportionally. For example: NACE 2 code 01.62 has two NACE 1 codes: 01.42 and 92.72. In that case we allocate 50% of 01.62 to NACE 1 code 01 and 50% to NACE 1 code 92.

3.2 Calculating the biodiversity footprint of companies

To calculate the footprint, we assume that the supply chains of sectors differ according to the continent where companies generate their turnover. The analysis by Wilting and Van Oorschot (2017) is at sector level. We therefore assume that companies in the same sector, which generate turnover on the same continent, have the same footprint per euro of turnover on that continent. The impact of the company on biodiversity is determined by continent. We multiply the biodiversity footprint per euro of turnover of the sector to which the company

belongs and the continent where the company generates turnover by the turnover on that continent.

In Wilting and Van Oorschot (2017), the biodiversity footprint is calculated per euro of production value of a sector. In the Statistics Netherlands (CBS[7]) definition, this is the value of all goods and services produced (the production value or output). There are three types of output: 1) market output: goods and services that have been sold on the market or for which this is the intention in the future; 2) output for a company's own final use: goods and services for a business's own consumption or for investments by the same business unit as the one that produced those goods and services; 3) non-market output: goods and services that are delivered to other units without charge or for prices that are not economically significant. We use the turnover figures of companies that are in the first category: market output.

We perform this calculation for all continents where the company operates and add together the impacts for all those continents to arrive at the company's total impact on biodiversity. For example: company I in the Agriculture sector generates 25% of its turnover in Europe and 75% in Asia. To arrive at the impact of company I, we take the weighted sum of the impacts on the continents of Europe and Asia for the Agriculture sector; weighting is based on turnover on the relevant continent.

The turnover data by region and market capitalisation are taken from Bloomberg and Refinitiv. The continental level is the level of detail at which a breakdown of turnover is available for many companies. When detailed turnover data are available, they are aggregated to world level.
In some cases, a company has aggregated turnover from multiple continents. In order to break this down by continent, we allocate turnover to a continent in proportion to GDP. The EMEA regions (Europe, Middle East and Africa) were allocated only to Europe and Africa, because in many cases there was also a separate Asia Pacific region. Allocating Middle East to Asia Pacific would give too much weight to the importance of Asia. Accounting allocations that are not linked to a region (e.g. Others, eliminations and adjustments) were omitted.

3.3 Financial sector's share of biodiversity footprint

The total biodiversity footprint of the company is then multiplied by that part of the company that is owned by Dutch financial institutions. This means that if the Dutch financial sector owns 1% of a company, 1% of that company's biodiversity footprint is attributed to the Dutch financial sector. This method is also used in the Partnership for Carbon Accounting Financials (PCAF) to attribute greenhouse gas emissions to financial institutions.

7 See the explanation of the table: Production and income components of GDP; branch; national accounts of Statistics Netherlands, https://opendata.cbs.nl/statline/#/CBS/nl/dataset/84088NED/table?ts=1585062197399.

In some cases the share of a Dutch financial institution was less than 0% or more than 100%. We presume that these are data errors, and we do not include these cases in the analysis.

3.4 Biodiversity footprint of the financial sector

If the above steps are carried out for all companies in the portfolio of Dutch financial institutions, this leads to the total impact of the Dutch financial sector (Impact NL FS):

$$Impact\ NL\ FS = \sum_{m=1}^{m} \frac{Value\ of\ invested\ capital\ NL\ FS_m}{Market\ capitalisation_m} * \sum_{j} Turnover_{m,j} * \frac{MSA*m^2*yr}{EUR}_{j,k} * \mathbb{1}\{m \in k\}$$

Where $m=\{1,...,M\}$ the number of companies in which Dutch financial institutions have holdings, $j=\{$North America, South America, Asia, Europe, Africa, Oceania$\}$ and $k=\{1,...,K\}$ the number of different sectors. Value of invested capital $NL\ FS_m$ is the capital invested by the Dutch financial sector in company m. $Market\ capitalisation_m$ is the total market capitalisation of company m. $Turnover_{m,j}$ is the turnover of company m on continent j. $\frac{MSA*m^2*yr}{EUR}_{j,k}$ is the footprint per EUR on continent j for sector k. Each company belongs to one sector, and the dummy variable equals 1 if company m is part of sector k.

As noted in Wilting and Van Oorschot (2017), the supply chains of different sectors overlap. For this reason, we only include that part of companies' turnover that is delivered to consumers and not to other companies. The part of turnover that is delivered to consumers is determined at sector level with the help of Input-Output tables.

Finally, based on the methodology of Wilting and Van Oorschot (2017), we determine – at sector level – which part of the footprint is attributable to changing land use and which part to greenhouse gas emissions.

4 Activities in biodiversity hotspots

In this analysis we determine whether and to what extent financial institutions invest in, or lend to, companies with business locations in protected areas, as referred to under the CBD, or in valuable areas (from the point of view of biodiversity) which currently do not have formal protected status under the CBD. The current target is to protect 17% of the land area (*Aichi* target 11). There is discussion ongoing within the CBD about a more ambitious target, with proposals that 30% of the land area be protected as natural areas by 2030. Decisions are expected to be made on this matter during CBD COP-15 in Kunming.

There is an international database for the areas that are currently protected.[8] We take the following steps to identify areas that are first in line for further protection from an ecological perspective: 1) areas already identified as "key biodiversity areas" or designated by the Alliance for Zero Extinction[9] but not yet protected; 2) areas classified as *Intact Forest Landscapes*[10] and also not yet protected; and 3) to arrive at 30% protection, additional areas have been selected in order of the significance of their contribution to preserving biodiversity. At the eco region level, we have used a "range rarity index" map for this process. This map indicates the importance of areas for the species found there, based on information about the habitats of mammals, amphibians and birds (Kok et al., 2020).

It is uncertain how many and which valuable areas will ultimately be granted protected status. This is a political choice. We therefore consider two scenarios: either 24% or 30% of the total surface of the Earth comes under protection. In figure 1, current protected areas are dark green. The areas that are added to these in steps 1 and 2, as explained above, make up the 24% scenario and are represented in a lighter shade of green. The bright green sections are additional areas that are added in step 3, in the 30% scenario.

The protected and valuable areas fit together rather like a set of Russian dolls (see figure 1). Every area that is currently protected is also part of the 24% and the 30% scenario. The areas in the 24% scenario are also part of the 30% scenario, but they are in addition to the currently protected areas. The additional areas in the 30% scenario are not in the areas now protected, nor are they in the 24% scenario (Kok et al., 2020).

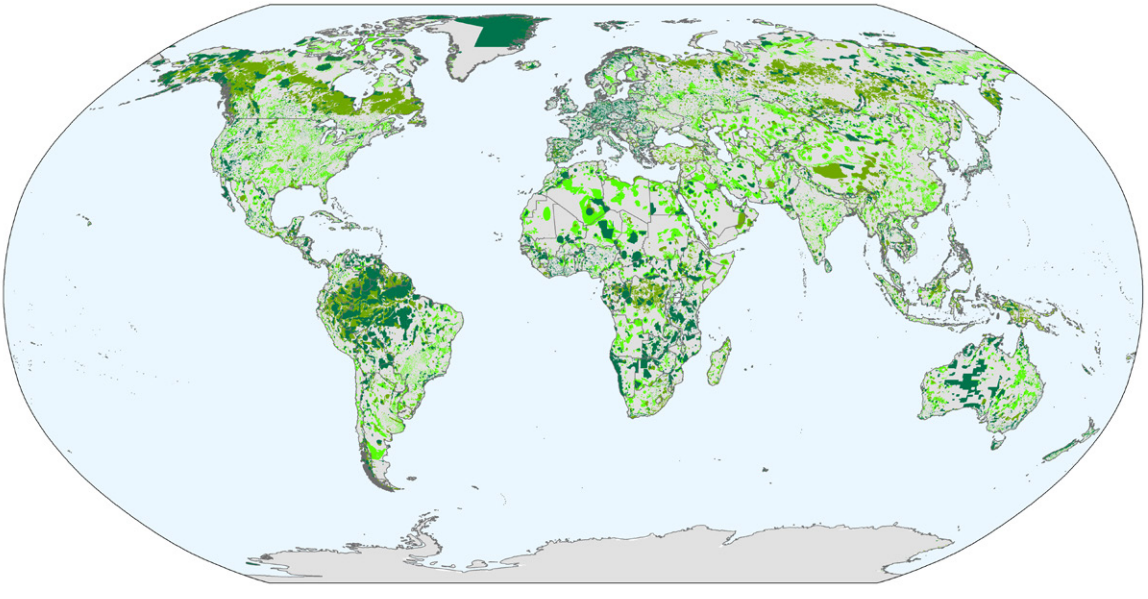
To link these protected and valuable areas to financial exposure, we use a dataset from Four Twenty Seven. The dataset contains 932,359 business locations of 1,846 major companies.

For each business location, it has been determined whether it is situated in one of the following four areas: protected area; valuable area in the 24% scenario; valuable area in the 30% scenario; and non-protected and non-valuable area. This is done for all companies and business locations.

We subsequently multiply, for each company, the invested capital in the company by the relative share

8 World Database for Protected Areas (WDPA); see https://www.protectedplanet.net/.
9 See https://zeroextinction.org/.
10 See http://www.intactforests.org/.

Figure 1 Current protected areas and scenarios for potential expansion based on ecological criteria



Current protected areas
Expansion 24% scenario
Expansion in 30% scenario

Sources: UNEP-WCMC, Kok et al. (2020)

of the business locations in protected and valuable areas in relation to the total number of business locations. We do this for all companies in the portfolio and then add up the exposures. For example: an insurer has invested EUR 4 million in a company with four business locations A, B, C and D. A is in a protected nature conservation area; B in a valuable area that is protected in the 24% scenario; C in a valuable area that is protected in the 30% scenario; and D in an area that is not and will not be protected. We assume that each site is of equal importance to the company and we therefore allocate EUR 1 million to each category. This means that EUR 1 million is in a protected area, EUR 2 million under the 24% target (EUR 1 million from the site already protected plus EUR 1 million from the site in a valuable area in the 24% scenario), and EUR 3 million in the 30% scenario. We have no further information about the business activities at a specific site.

The capital invested in the companies is determined using the statistics of the equity and bond holdings of pension funds, insurers and banks, and based on a database for business loans from banks.

5 The Dutch nitrogen crisis

Nitrogen emissions are reported on the basis of Large-scale Concentration Maps in the Netherlands (Grootschalige Concentratiekaarten Nederland – GCN) sectors. To make a link to the Dutch financial sector, these sectors have to be translated into NACE REV 2 sectors. As there is no table to translate from GCN to NACE REV 2, we did this manually.

Based on the GCN sectors, we translated the various sources of nitrogen (nitrogen oxides and ammonia) into N equivalents. We then calculated the nitrogen emissions of GCN sector as a share of total emissions by the Netherlands.[11] Next, we linked NACE REV 2 to GCN, so that we could link the shares of emissions belonging to GCN to NACE REV 2 sectors. In some cases there are multiple GCN sectors that belong to one single NACE REV 2 sector. In such cases we use the GCN sector with the largest share of nitrogen out of total GCN emissions. For example: NACE REV 2 sector 01.50 – mixed farming can be associated with at least five different GCN sectors: 4112: Agriculture-Livestock farming-Stalls-Other livestock, 4200: Agriculture-Chemical fertiliser use, compost, sewage sludge, crop protection products and harvests, 4140: Agriculture-Livestock farming-Fertiliser use, 4130: Agriculture-Livestock farming-Grazing, and 4120: Agriculture-Livestock farming-Fertiliser storage. In this case the activity with the highest emissions is linked to NACE REV 2 sector 01.50, i.e. 4140: Agriculture-Livestock farming-Fertiliser use.

It is also possible for one GCN sector to be linked to multiple NACE sectors. For example: rail transport (GCN 3700) is linked to Passenger rail transport, interurban (49.10) and Freight rail transport (49.20).

In the analysis we use the data from the 2017-IV loan books of the three largest Dutch Banks (ABN Amro, ING, Rabobank).[12] We use the incidences of exposure at the most detailed NACE REV 2 level available. Each NACE REV 2 sector is classified into one of the following categories: 0% of total nitrogen emissions, <2.5%, 2.5%-5.0%, 5.0%-7.5% or >7.5%. The last category means that the NACE REV 2 sector is linked to a GCN sector that accounts for more than 7.5% of total emissions.

In the loan books of the three largest banks, no distinction is made between domestic and foreign loans. Based on data from the annual reports of the three banks, we divide total exposure between the Netherlands and foreign countries. On page 73 of Rabobank's 2017 annual report, exposure for the Food & Agri sector is divided into 38% domestic and 62% foreign. We apply this division to NACE REV 2 sectors 01, 02 and 03. For the remaining sectors, classified in the Rabobank annual report as Trade, Industry and Services, the division is 70% domestic and 30% foreign. We use this division for the remaining NACE REV 2 sectors.

11 As nitrogen deposition can ultimately have a negative impact on nature, nitrogen deposition data would have been more applicable. However, the level of detail regarding sectoral contributions to this deposition is considerably lower than the level relating to sectoral contributions to emissions. This has obliged us to use data on emissions.

12 The loan books of banks that we use here contains only loans and not the value of the collateral, such as the value of land.

14 On page 252 of ING's 2017 annual report, a division is reported for wholesale banking of 13% for the Netherlands and 87% for other countries. We use this division for ING. Finally, on page 83 of ABN Amro's 2017 annual report, the division for Corporates is 55% domestic and 45% foreign.

6 Involvement in controversial activities

As a measure of the reputational risk of the Dutch financial sector, the indicator we use is whether their investments appear in the MSCI controversies database. MSCI classifies each controversy into one of the following four categories: Minor/None, Moderate, Severe, Very Severe. Our analysis focuses only on the last three categories. To this end, we use the MSCI data on controversies from 1 December 2019. This database contains information for 16,397 securities on whether any involve a controversy and the severity of the controversy.

MSCI divides the controversies into the categories Environment (E), Social (S) and Governance (G). For our analysis we focus on dimensions within E and we select the dimensions that have a negative impact on nature: ENVIRONMENT_LAND_ ASSESSMENT, ENVIRONMENT_WASTE_ASSESSMENT, ENVIRONMENT_OTHER_ASSESSMENT ENVIRONMENT_SUPPLY_ASSESSMENT, ENVIRONMENT_TOXIC_ASSESSMENT and ENVIRONMENT_WATER_ASSESSMENT.

For pension funds, insurers and banks, we look at the holdership of equity and bond investments in companies. We also use a database for business loans from banks.

7 Reputational damage due to inadequate information provision about deforestation risks

The analysis is based on the results of the CDP reporting standard for forests for 2019. In 2019 the CDP approached 1,418 companies, requesting that they fill in the reporting standard. The CDP selects the companies that they approach based on a number of criteria: i) the amount of income from business activities related to deforestation through the use of palm oil, soya, timber, natural rubber or livestock products, ii) the merger of companies from various regional and international stock exchange indices, and iii) companies identified as Global Canopy's Forest 500 "deforestation powerbrokers". A more detailed explanation of the selection criteria can be found here.
Of the total, 1,117 companies did not respond, while 259 companies provided information. Of those 259 businesses, 116 did not make the information public. Non-public responses are only available to investors with access to the CDP database.

Based on the results of this reporting standard, we classified companies according to the extent to which they could represent a reputational risk for financial institutions. We distinguished four categories.

i. iCategory 1: Companies which in all likelihood have risky products or activities in their production processes and value chain, but which do not report anything about these to the CDP;
ii. Category 2: Companies which in all likelihood have risky products or activities in their production processes and value chain, but which do not publish information on this subject;
iii. Category 3: Companies which have risky products or activities in their production processes and value chain and which take little or no action to address deforestation risks;
iv. Category 4: Companies which have risky products or activities in their production processes and value chain and which take measures to address deforestation risks.

To determine whether companies take action to address deforestation risks in their production processes and value chain, we looked at companies' answers in the CDP reporting standard to the questions on the availability of i) a framework for assessing deforestation risks, ii) a policy for reducing deforestation risks, iii) oversight at management board level, and iv) public commitments to reduce or eliminate deforestation risks.
Companies that give a maximum of two affirmative answers to the questions above are put into category 3. Companies that give more than two affirmative answers are put into category 4. The complete questionnaire can be found here.

The exposure of Dutch financial institutions to these companies is derived from the statistics of the equity and bond holdings of pension funds, insurers and banks, and based on a database for business loans from banks.

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