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RAINFOREST PROJECT SUMMARY

Co-produced transformative knowledge to accelerate change for biodiversity

Food and biomass production systems are among the most prominent drivers of biodiversity loss worldwide. Halting and reversing the loss of biodiversity therefore requires transformative change of food and biomass systems, addressing the nexus of agricultural production, processing and transport, retailing, consumer preferences and diets, as well as investment, climate action and ecosystem conservation and restoration. The RAINFOREST project will contribute to enabling, upscaling and accelerating transformative change to reduce biodiversity impacts of major food and biomass value chains. Together with stakeholders, we will co-develop and evaluate just and viable transformative change pathways and interventions. We will identify stakeholder preferences for a range of policy and technology-based solutions, as well as governance enablers, for more sustainable food and biomass value chains. We will then evaluate these pathways and solutions using a novel combination of integrated assessment modeling, input-output modeling and life cycle assessment, based on case studies in various stages of the nexus, at different spatial scales and organizational levels. This coproduction approach enables the identification and evaluation of just and viable transformative change leverage points, levers and their impacts for conserving biodiversity (SDGs 12, 14-15) that minimize trade-offs with targets related to climate (SDG13) and socioeconomic developments (SDGs 1-3). We will elucidate leverage points, impacts, and obstacles for transformative change and provide concrete and actionable recommendations for transformative change for consumers, producers, investors, and policymakers.

EXECUTIVE SUMMARY

This case study aims to develop and apply a methodology to quantify climate and biodiversity footprints of investment portfolios. The white paper aims to provide an overview of the approach, data requirements, and interpretation of the results. We quantify climate and biodiversity footprints of individual companies in several steps. First we link company-specific scope 1 and scope 2 environmental pressures (based on company assessments) to country- and sector-specific scope 3 environmental pressures (based on environmentally extended multiregional input-output analysis) to quantify direct (scope 1) and indirect (scope 2 and 3) environmental pressures along company value chains. This requires company-level environmental pressure and revenue data, as well as country- and sector-level input-output data. Subsequently, we combine the direct and indirect environmental pressures with LC-IMPACT and GLOBIO environmental impact assessment models to quantify the climate and biodiversity footprints of the investment portfolios.

1 INTRODUCTION

While greenhouse gas (GHG) footprints are often considered by investors to assess the sustainability of investments, biodiversity loss has received little attention in decision making regarding investments (Pereira et al., 2013; Narain et al., 2020; Goedkoop et al., 2022; Lamont et al., 2023). Investors can allocate capital away from those who contribute to biodiversity degradation to those who help to alleviate it. As a result, investors can play an important role in addressing the biodiversity funding gap by identifying company impacts on biodiversity. In turn, this could provide incentive for companies to reduce both climate and biodiversity impacts.

We aim to quantify climate and biodiversity footprints related to investment portfolios by considering the direct and indirect impacts of all companies within a portfolio. Investment portfolios typically consist of ~100 companies spread over different economic sectors.

2 BACKGROUND

Climate change and biodiversity loss pose significant threats to the environment, ecosystem, and human society (Newbold et al., 2015; Pörtner et al., 2023). To alleviate climate change and to reach the Paris Agreement goals, as well as halt biodiversity loss to reach the Kunming-Montreal Global Biodiversity Framework (GBF) goals, countries have pledged to reduce emissions and protect biodiversity. Meeting these targets also depends on the actions of non-state actors (Krabbe et al., 2015; Cenci et al., 2023): Companies, for example, are responsible for 71% of the global industrial GHG emission since 1988, highlighting that they are important actors in mitigating climate change (CDP, 2017; Dietz et al., 2018). In addition, the Kunming-Montreal GBF urges companies and financial institutions to assess and disclose their impacts on biodiversity.

As climate and biodiversity regulations become increasingly strict, investors allocate a greater share of their capital to companies with lower GHG and biodiversity footprints, to reduce the climate and biodiversity risks associated with their investment. Information on the companies' GHG and biodiversity footprints are also the basis for climate- and biodiversity-efficient capital allocation. For this, it is critical to ensure measurement of climate and biodiversity footprints at company level.

Company reporting is a valuable tool for assessing a company's environmental footprint by providing essential information related to resources consumption, emissions, and other environmental metrics. In 2023, the Corporate Sustainability Reporting Directive (CSRD) entered into force. This new directive will ensure that investors and other stakeholders have access to the information they need (such as companies' climate change mitigation and adaptation) to assess the impact of companies on the environment, and for investors to assess financial risks and opportunities that arise from climate change and other sustainability issues (European Union, 2022). The significance of reporting on climate and biodiversity is becoming increasingly clear, promoting companies to understand how ongoing operations activities affect environment and capture their sustainability improvements (Wassénius et al., 2024; Michalak et al., 2023).

In addition to company reporting, non-profit organizations, such as the Carbon Disclosure Project (CDP), also run disclosure system for companies to manage their environmental impacts with focus areas covering climate, water, forests and plastics. CDP has compiled company environmental impact monitoring data since 2000, forming a large database of environmental impacts associated with companies. The CDP helps company to track primary data collection for upstream emissions through its 'Supply Chain Program', which contains emissions data of over 5500 tier 1 suppliers of 115 member companies (Klaaßen & Stoll, 2021). Although the scope 1 (i.e., direct environmental impacts) and scope 2 (environmental impacts related to direct energy consumption) data are relatively well documented, scope 3 (environmental impacts upstream in the value chain) data availability is limited (30% of the companies report their scope 3 emissions). Therefore, most companies cannot quantify emissions along their whole value chain.

The Greenhouse Gas Protocol released a technical guidance for calculating scope 3 emissions, several methods have been proposed to estimate value chain carbon footprints, such as economic input-output models, process-based models, and a hybrid of the two (WRI & WBCSD, 2013; Minx et al., 2009; Suh et al., 2001). Economic input-output modeling is a 'top-down' approach that relates national- and sector-level trade flows to environmental impacts to quantify national and sector production and consumption footprints. This approach includes a broad range of environmental extensions so as to evaluate different environmental footprints. In contrast, process-based modeling is a bottom-up technique that involves specific and detailed information on a particular process. A hybrid model starts with a bottom-up estimate and fills the gaps with top-down figures (Wiedmann, et al.,2009).

Though carbon footprints are relatively well-documented by CDP, but its coverage of other environmental areas, such as biodiversity impacts (which started to be collected in 2021), remains limited.

The drivers of climate change and biodiversity loss mainly arise from human activities such as land-use change, resource extraction, and energy production, typically driven by consumption in regions other than where the impacts occur. Such tele-coupling effects can be explored by using footprint indicators (e.g., GHG footprint, biodiversity footprint). Linking consumption with production elsewhere by considering economic value chains and national trade flows enables the identification of environmental footprints (Lenzen et al., 2012).

Traditional economic input-output models are based on the Leontief input-output framework, which is suitable for evaluating the environmental impacts along the value chain that is induced by a final demand. However, a company's output is not always delivered to final consumers, and most of the outputs are further processed by other businesses. Therefore, the traditional economic input-output analysis might underestimate the carbon emissions embodied in the downstream value chains of a company (Hertwich, 2021). Zhang et al. (2020, 2023) integrated an economic input-output framework with a hypothetical extraction method (HEM) to trace a company's carbon footprint along the value chain.

For biodiversity footprints, Iceberg Data Lab (IDL) developed the corporate biodiversity footprint (CBF) tools to measure and manage financial institution's impacts, dependencies, risks, and opportunities associated with biodiversity (IDL, 2023). According to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), land use change, natural resource use and exploitation, climate change, pollution, and invasive species are the five main pressures that are responsible for biodiversity loss (IPBES, 2019). The CBF measure aims at covering these pressures on biodiversity and use Mean Species Abundance (MSA) to quantify biodiversity loss. By using a customized input-output model, the CBF performs analysis based on products and assesses their impact through the value chain. Although biodiversity footprints are increasingly studied by input-output models, these models typically distinguish sectors within countries or larger regions, but do not quantify the footprints of specific companies (Scherer et al., 2016; Wilting et al., 2017; Marquardt et al., 2019; Wilting et al., 2021; Cabernard et al., 2022).

There is an urgent need to combine company's scope 1 emissions data with input-output models to capture supply chain scope 3 emissions, as well as to extend a company's climate footprint to a biodiversity footprint, to more comprehensively assess companies' climate and biodiversity impacts.

3 METHODOLOGY

3.1 Method

Understanding the investment portfolio data is an essential step in identifying potential companies as research objectives. We combine the company-level scope 1 and scope 2 greenhouse gas (GHG) emissions and land use (CDP, 2023) with an environmentally extended multi-regional input-output (EEMRIO) model (Stadler et al. 2018) to estimate company-level scope 3 GHG emissions and land use footprint. Subsequently, we will link the land use footprint to environmental impact assessment models to quantify the land use based biodiversity footprints (Verones et al. 2020, Schipper et al. 2020). As a results, we are interested to know the variations in climate and biodiversity footprints among various investment portfolios. Figure 1 shows a schematic overview of the four steps to quantify investment portfolios' climate and biodiversity footprints.

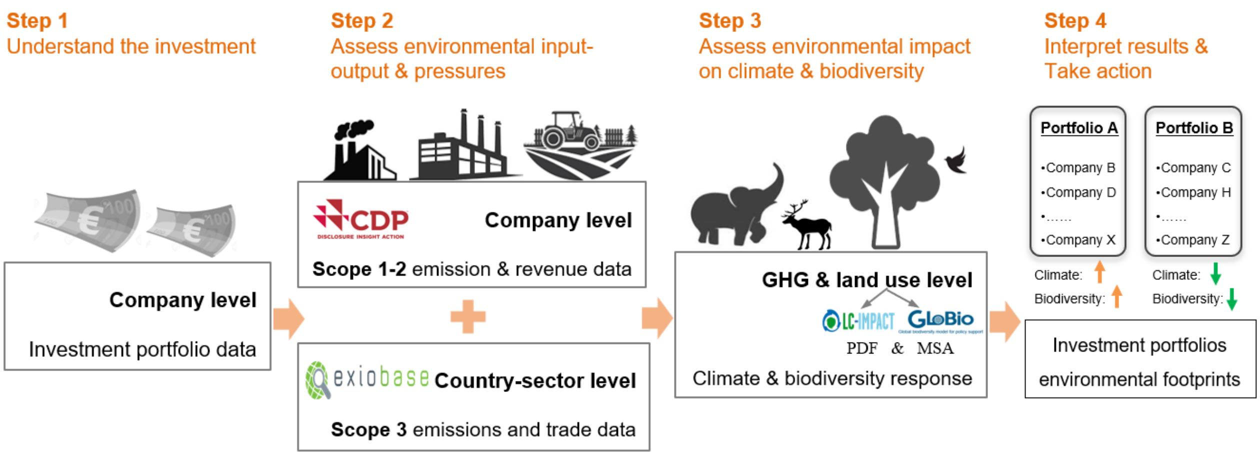

Figure 1. Overall schema to quantify investment portfolios' environmental impacts

Step 1: Understand the investment. In this step, we will collect investment portfolio data containing lists of investments into companies.

Step 2: Assess environmental input-output and environmental pressures. In this step we will identify GHG emissions and land use related to the supply chains (considering scopes 1-3) of the companies in the investment portfolios. Scope 1 comprises direct GHG emissions from sources owned or controlled by a company; scope 2 comprises indirect GHG emissions associated with the energy use by the company; scope 3 comprises are all other indirect (upstream) GHG emissions and land use (not included in scope 2) including the total supply chain up to the production gate.

For scopes 1-2, we use the Carbon Disclosure Project (CDP, 2023) database for collecting company-level scope 1 and scope 2 GHG emissions. In addition, we will compile company revenue data to be able to link the companies to the EEMRIO model for estimating scope 3 emissions and land use.

We use the EEMRIO model EXIOBASE to calculate average scope 3 indirect emissions and land use corresponding to the supply chain of the economic sector of the company. The EXIOBASE database depicts the trade flows between sectors and countries (Stadler, et al., 2018), enabling the modelling of average value chains when more accurate value chain data are unavailable.

As EXIOBASE data is organized by region and sector, company revenue data can be used to allocate part of the sectoral GHG emissions and land use. Some multinational companies are active across several economic sectors. We will then allocate company impacts to the different sectors based on company product-segment revenue data (See Figure 2 for an example of Unilever revenue data).

Region	Revenue (€ million)	Percentage
Asia Pacific Africa	27504	45.8%
The Americans	20905	34.8%
Europe	11664	19.4%
Total	**60073**	**100%**

Beauty (€ million)	Personal care (€ million)	Home care (€ million)	Nutrition (€ million)	Ice cream (€ million)
5610.5	6245.3	5679.7	6365.3	3612.7
...	...	...	...	...

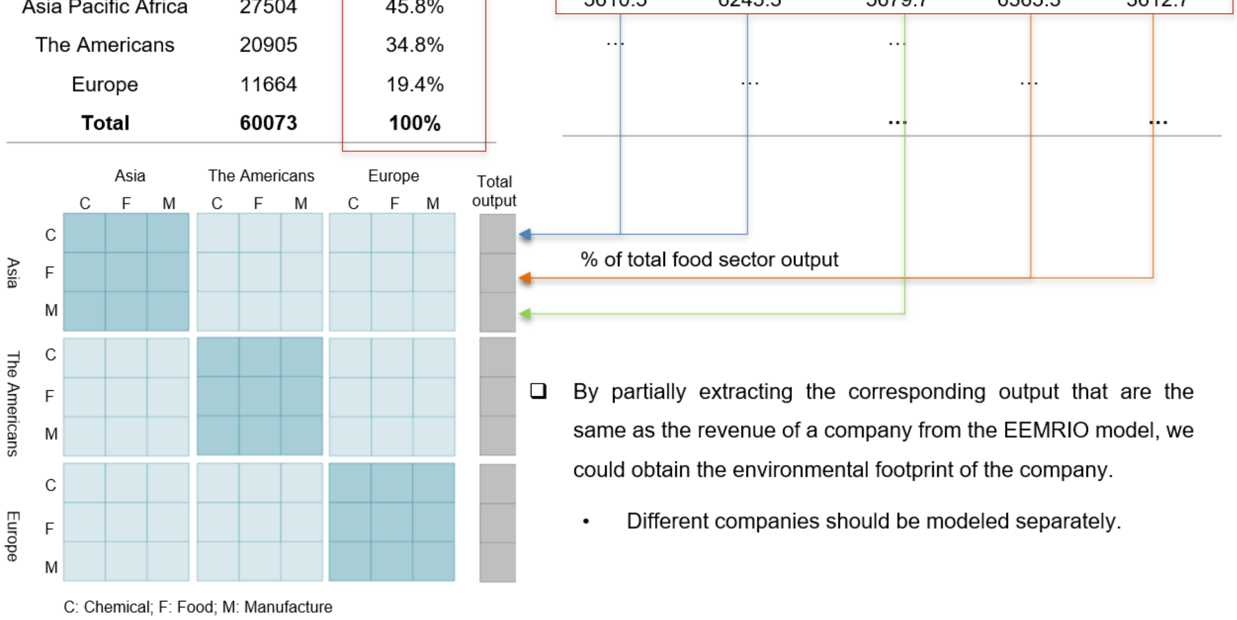

Figure 2. Linking company's revenue data to EEMRIO.

CDP typically does not disclose direct (scope 1) or indirect (scope 2) land use data. Therefore, we will consider scope 3 land use impacts only based on EXIOBASE land use footprint data. Although this will lead to an underestimation of land use impacts, we believe that this is reasonable as most of the land use footprints take place upstream in the value chain (e.g., in agricultural activities and resources extraction) (Costello et al., 2011). In short, for climate-related environmental footprints, scope 1, scope 2 and scope 3 emissions will be considered, while, for land-use based footprints, only scope 3 will be considered due to data availability.

Step 3: Assess environmental impact on biodiversity. We will link the company supply chain GHG emissions and land use to LC-IMPACT and GLOBIO environmental impact assessment models to estimate biodiversity impacts to corresponding climate and habitat change pressures (Verones et al., 2020; Schipper et al., 2020). By quantifying the climate and biodiversity footprints of each company, we can quantify the total footprints of the investment portfolios. The biodiversity loss can be expressed in terms of global species extinctions (potentially disappeared fraction of species) (LC-IMPACT methodology) and ecosystem intactness (mean species abundance) (GLOBIO methodology).

Step 4: Interpret results. The insights generated from the biodiversity assessment can be used to understand the impact of investments on climate and biodiversity by identifying which companies and sectors are driving the impacts and whether investments can be shifted to minimize environmental impacts.

3.2 Data

Table 1 shows the data used to calculate climate and biodiversity footprints, which include company information, environmental pressure, social-economic data and biodiversity indicators.

Table 1. Summary of the data.

<table>
<tr><th>Attribute</th><th>Data</th><th>Source</th></tr>
<tr><td rowspan="2">Company information</td><td>Investment data</td><td>Robeco / MSCI</td></tr>
<tr><td>Revenue data</td><td>Company annual report</td></tr>
<tr><td rowspan="2">Environmental pressure</td><td>scope 1 & 2 CO_2 emission
(For climate impact)</td><td>CDP</td></tr>
<tr><td>Land use
(For biodiversity impact)</td><td>EXIOBASE</td></tr>
</table>

Social-economic data	Environmentally extended multi-regional input-out table	EXIOBASE
Land use based biodiversity indicator	Potentially disappeared fraction of species (PDF)	LC-IMPACT
	Mean species abundance loss (MSA)	GLOBIO

4 DISCUSSION

The quantification of climate and biodiversity footprints of investment portfolios based on the footprints of individual companies enables financial institutions to evaluate how they can shift their investment portfolios to minimize negative climate and biodiversity impacts. Insights into the climate and biodiversity impact of different portfolios not only enables a focus on company's sustainable performance, but also serves as a reference to climate and biodiversity policy, to develop or adjust investment criteria and to inform investment decisions. Promoting the establishment of the climate and biodiversity footprints assessment framework will also likely feed the momentum for companies to enhance their reporting, laying some of the groundwork for putting climate and biodiversity at the heart of a clear and workable system for environmental reporting.

5 CONCLUSION

The investment portfolio case study aims to develop and apply an approach to quantify climate and biodiversity footprints of investment portfolios. This white paper provides insight into current methods used to quantify environmental footprints of financial institutions, into the proposed novel methodology to quantify climate and biodiversity footprints, and the corresponding data requirements. By collecting company level investment and revenue data, environmental pressure data, and input-output data, we can calculate direct company-level impacts and indirect average upstream environmental pressures of company value chains. Subsequently combined with LC-IMPACT and GLOBIO characterization factors, we are aiming to show biodiversity footprints corresponding to the investment portfolios. This will enable financial institutions to assess the environmental footprints related to their investments, allowing the identification of investment strategies to minimise climate and biodiversity impacts.

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