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Investigating Corporate Visibility of National Ecosystem Accounting Data: A
Content Analysis

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Abstract

Purpose – This thesis aims to examine how ecosystem service-related information understood as information on the benefits and functions provided by ecosystems becomes visible in corporate sustainability reports of the DAX companies and to what extent such information is explicitly anchored in references to national ecosystem accounting (NEA). NEA refers to the integration of ecosystem assets and ecosystem service flows into national accounting systems.

Design/methodology/approach – This study is based on a quantitative content analysis of 40 corporate reports published by DAX companies in 2024. It analyzes the five environmental European Sustainability Reporting Standards (ESRS) topics: E1 Climate Change, E2 Pollution, E3 Water and Marine Resources, E4 Biodiversity and Ecosystems, and E5 Resource Use and Circular Economy. A deductively developed codebook captures the thematic coverage of ecosystem service-related content, its form of representation (qualitative, physical, monetary, or analytical), and whether it is explicitly anchored in external or national ecosystem accounting-related references.

Findings – The results demonstrate the selective visibility of ecosystem service-related information. Climate change clearly dominates reporting while other environmental topics are addressed less consistently. Qualitative representations constitute the primary reporting format whereas physical and analytical information appears only as a supplement. Monetary representations remain rare and are largely confined to the climate change context. Explicit references to national ecosystem accounting are absent.

Originality/value – This thesis contributes to research at the intersection of sustainability accounting, ecosystem accounting, and corporate reporting by examining the visibility of national ecosystem accounting in ESRS-related corporate reporting. The findings show that the limited explicit anchoring of national ecosystem accounting is driven less by lack of data than by translation and alignment problems between national accounting logics and corporate reporting practices.

Abstrakt

Zielsetzung – Diese Arbeit untersucht, wie Ecosystem Service relevante Informationen, verstanden als Informationen über die von Ökosystemen bereitgestellten Nutzen und Funktionen, in der Nachhaltigkeitsberichterstattung von den DAX-Unternehmen sichtbar wird und in welchem Ausmaß solche Informationen explizit durch Verweise auf National Ecosystem Accounting (NEA) verankert sind. NEA bezeichnet die Integration von Ökosystemvermögen und Ökosystemdienstleistungsflüssen in nationale Rechnungslegungssysteme.

Design/Methodik – Die Studie basiert auf einer quantitativen Inhaltsanalyse von 40 Unternehmensberichten, die von DAX-Unternehmen für das Berichtsjahr 2024 veröffentlicht wurden. Analysiert werden die fünf umweltbezogenen Themen der European Sustainability Reporting Standards (ESRS): E1 Climate Change, E2 Pollution, E3 Water und Marine Resources, E4 Biodiversity und Ecosystems, und E5 Resource Use und Circular Economy. Ein deduktiv entwickeltes Codebook erfasst die thematische Abdeckung Ecosystem Service relevanter Inhalte, ihre Darstellungsform (qualitativ, physisch, monetär oder analytisch) sowie die Frage, ob sie explizit in externen oder auf National Ecosystem Accounting bezogene Referenzen verankert sind.

Ergebnisse – Die Ergebnisse zeigen die selektive Sichtbarkeit Ecosystem Service relevanter Informationen. Climate Change dominiert die Berichterstattung deutlich, während andere Umweltthemen weniger konsistent adressiert werden. Qualitative Darstellungen stellen das primäre Berichtsformat dar, während physische und analytische Informationen nur ergänzend auftreten. Monetäre Darstellungen bleiben selten und sind weitgehend auf den Klimakontext beschränkt. Explizite Verweise auf National Ecosystem Accounting sind nicht vorhanden.

Originalität/Beitrag – Diese Arbeit leistet einen Beitrag zur Forschung an der Schnittstelle von Sustainability Accounting, Ecosystem Accounting und Corporate Reporting, indem sie die Sichtbarkeit von National Ecosystem Accounting in der ESRS-bezogenen Unternehmensberichterstattung untersucht. Die Ergebnisse zeigen, dass die begrenzte explizite Verankerung von National Ecosystem Accounting weniger auf einen Mangel an Daten als auf Übersetzungs- und Anschlussprobleme zwischen nationalen Rechnungslogiken und unternehmensbezogenen Berichtspraktiken zurückzuführen ist.

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List of Abbreviations

CICES.....	<i>Common International Classification of Ecosystem Services</i>
CSRD	<i>Corporate Sustainability Reporting Directive</i>
DAX	<i>Deutscher Aktienindex</i>
ES	<i>Ecosystem services</i>
ESG	<i>Environmental Social Governance</i>
ESRS	<i>European Sustainability Reporting Standards</i>
EU.....	<i>European Union</i>
GDP	<i>Gross Domestic Product</i>
GHG	<i>Greenhouse gas</i>
GRI	<i>Global Reporting Initiative</i>
KPI	<i>Key Performance Indicator</i>
LSEG.....	<i>London Stock Exchange Group</i>
MEA	<i>Millennium Ecosystem Assessment</i>
NAICS	<i>North American Industry Classification System</i>
NEA.....	<i>National Ecosystem Accounts</i>
NFRD	<i>Non-Financial Reporting Directive</i>
SDGs	<i>Sustainable Development Goals</i>
SEEA.....	<i>System of Environmental-Economic Accounting</i>
SEEA EA.....	<i>System of Environmental-Economic Accounting Ecosystem Accounting</i>

SEEA EEA *System of Environmental-Economic Accounting Experimental Ecosystem Accounting*
SNA *System of National Accounts*
UN *United Nations*

1. Introduction

National ecosystem accounting (NEA) is the integration of ecosystem assets and services into national accounting systems (Edens & Hein, 2013, p. 41; Obst et al., 2016, p. 9). The purpose of NEA is to make ecological conditions and service flows visible in a structured way and to connect them to economic information systems (Edens & Hein, 2013, p. 41; Obst et al., 2016, p. 9; Vallecillo, La Notte, Zulian, et al., 2019, p. 197). For instance, a national ecosystem account could document the size and state of forests and connect these assets to services such as carbon sequestration, water regulation, and recreation (Bruzón et al., 2022, p. 2; Edens et al., 2022, pp. 2–3; King et al., 2023, p. 4). Thus, NEA reveals ecological contributions that conventional economic indicators, such as GDP, often fail to capture (Edens et al., 2022, pp. 5–6; Hein et al., 2020, p. 514).

The concept of ecosystem services (ES) is closely connected to NEA. These services describe the benefits that humans derive from ecosystems (Baskent, 2020, p. 1; Chen et al., 2023, p. 1; Small et al., 2017, p. 58). The benefits include material contributions, such as food, water, and raw materials, regulating contributions, such as climate regulation and water purification, as well as non-material contributions, such as recreation and aesthetic value (Baskent, 2020, p. 6; Millennium Ecosystem Assessment, 2005, p. 40). For example, wetlands can provide services such as reducing flood risks, filtering water, and offering recreational opportunities to local communities (Baskent, 2020, pp. 2, 6; Millennium Ecosystem Assessment, 2005, p. 40).

This connection becomes increasingly relevant in corporate sustainability reporting. Global environmental issues such as climate change, biodiversity loss, and resource scarcity have significantly increased the importance of ecological information for economic decision-making processes (Akhter et al., 2023, p. 343). Companies are under growing pressure from investors, regulatory authorities, and other stakeholders to transparently communicate their environmental impacts and integrate sustainability aspects into their reporting (Miklosik & Evans, 2021, p. 3; Schwoy et al., 2025, p. 666). In this context, sustainability accounting, understood as a goal-driven set of tools for measuring, managing, and reporting environmental, social, and economic information related to corporate sustainability, is becoming increasingly important as accounting systems play a central role in measuring ecological impacts and incorporating them into decision-making processes (Grunewald et al., 2024, p. 1; Schaltegger & Burritt, 2010, pp. 379–382; Singhanian et al., 2025, pp. 1699–1700). One key approach to integrating environmental information into economic systems is ecosystem accounting. The internationally

recognized System of Environmental-Economic Accounting Ecosystem Accounting (SEEA EA) provides a standardized framework for ecosystem accounting while NEA operationalizes this framework at the national level by recording ecosystem assets and service flows in physical and monetary units (Grunewald et al., 2024, p. 3; Singhania et al., 2025, p. 1700). To illustrate this accounting logic the NEA can be understood as a structured approach to determining a country's ecosystems, their condition, and the services they provide to society and the economy. Rather than only recording economic output from land use, for example, an ecosystem accounting may also capture changes in forest area or wetland conditions over time and how these changes affect services such as carbon sequestration and flood protection (Edens et al., 2022, pp. 2–3; Edens & Hein, 2013, p. 41; Obst et al., 2016, p. 9). Such approaches are intended to integrate ecological information more closely into political and economic decision-making processes and to create a basis for more sustainable forms of management (Grunewald et al., 2024, p. 40; Singhania et al., 2025, pp. 1717–1719).

Figure 1 summarizes this logic by illustrating the conceptual relationship between the central terms used in this thesis. SEEA EA provides the overarching statistical framework for ecosystem accounting, while NEA represents its implementation at the national level. Within this logic ecosystem assets generate ES which may become visible in corporate sustainability reporting.

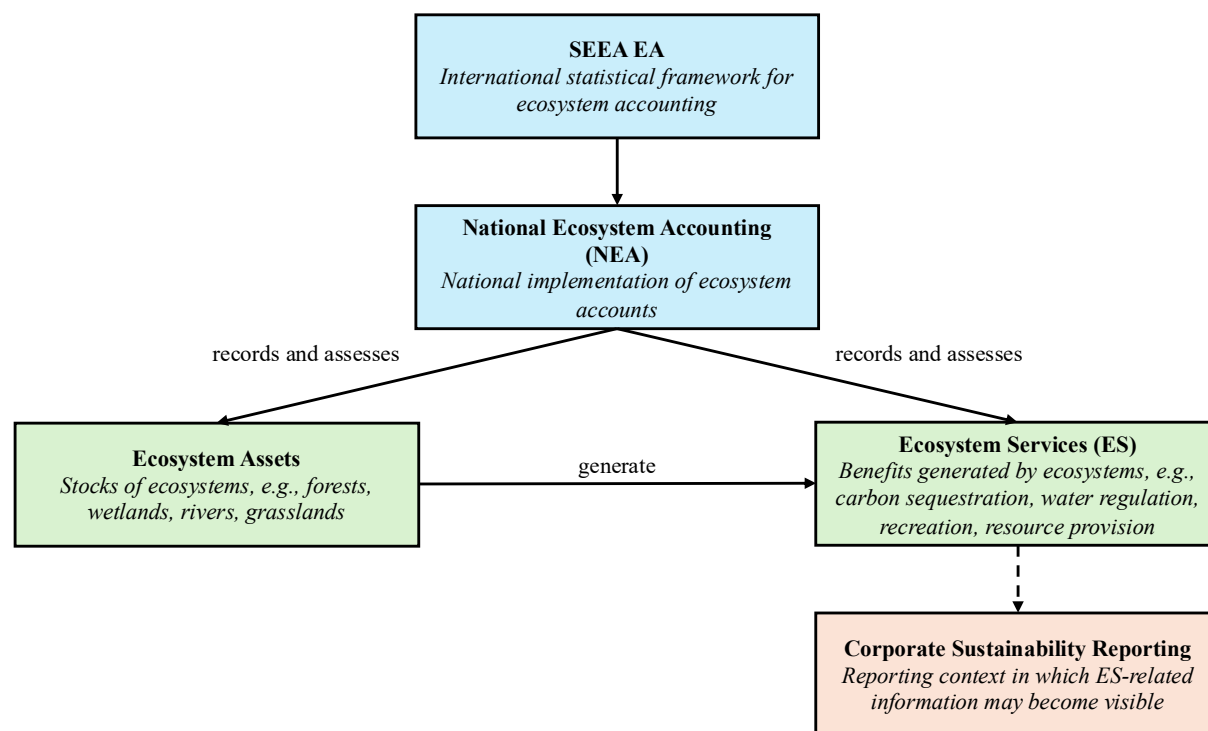


Figure 1: Conceptual relationship between SEEA EA, NEA, ecosystem assets, ES, and corporate sustainability reporting

Alongside the development of ecosystem accounting approaches extensive research has been conducted on corporate sustainability reporting. Empirical studies show that companies increasingly disclose environmental information in their reports but mainly focus on issues that are comparatively easy to quantify and attract high public attention. In particular, energy consumption and greenhouse gas emissions are reported frequently whereas other environmental issues such as biodiversity and ecosystem services receive considerably less attention (Borgstedt et al., 2019; Cubilla - Montilla et al., 2020; Papafloratos et al., 2023; Taşoğlu et al., 2024). At the same time, research on ecosystem services and ecosystem accounting points to substantial methodological challenges. While different approaches to the quantitative or monetary valuation of ecosystem services exist they often require extensive assumptions, data harmonization, and methodological decisions (Taye et al., 2021, pp. 9–10). Although NEA provides a standardized framework for integrating ecosystem services into national accounting systems, the usefulness of such information beyond political and statistical contexts remains limited. Moreover, NEA and corporate reporting differ considerably in their underlying logic. While NEA aims to provide standardized, spatially aggregated, and methodologically consistent environmental information, corporate reporting is more strongly shaped by company-specific communication needs and stakeholder-oriented requirements (Grunewald et al., 2024, p. 29; Obst et al., 2016, p. 9). In practice, companies therefore often simplify complex ecological relationships, report predominantly in qualitative terms, or refrain from making direct references to NEA data (Akhter et al., 2023, p. 357; Grunewald et al., 2024, pp. 21, 26–27, 29–30). This suggests that the existence of standardized ecosystem accounting information does not automatically imply its uptake in corporate reporting. Rather, it points to a possible translation gap between the standardized logic of ecosystem accounting and the firm-level logic of corporate disclosure.

A growing body of literature has examined ecosystem accounting including the development of SEEA EA, ecosystem service accounts, and natural capital accounting at national or territorial levels (Comte et al., 2022; Edens et al., 2022; Hein et al., 2020; Obst et al., 2016; Vallecillo, La Notte, Zulian, et al., 2019). In parallel, corporate sustainability reporting research has analyzed how firms disclose environmental topics, which issues receive reporting attention, and how such disclosures are communicated in corporate reports (Borgstedt et al., 2019; Cubilla-Montilla et al., 2020; Miklosik & Evans, 2021; Papafloratos et al., 2023; Schwoy et al., 2025; Taşoğlu et al., 2024). However, the connection between these two fields has not yet been adequately explored (D’Amato et al., 2024, p. 1032). A recent overview study in sustainability accounting (Singhanian et al., 2025) also shows that emerging accounting approaches have so

far only been examined to a limited extent in organizational contexts (Singhania et al., 2025, pp. 1719–1720). It therefore remains unclear whether and how firms use environmental information generated through ecosystem accounting in their own sustainability reporting practices. More specifically, it is still largely unknown whether ecosystem service-related information recorded in NEA is adopted, translated, or operationalized in corporate sustainability reporting.

This gap is relevant because it is not only a question of whether companies report on nature-related issues, but also of whether reporting practices reflect accounting logics that are compatible with ecosystem accounting in the first place. This leaves an important research gap regarding whether and how ecosystem accounting approaches become visible in the corporate context beyond their original political and statistical setting.

Against this backdrop this thesis examines the corporate visibility of ecosystem service-related information in corporate sustainability reporting. Corporate visibility is understood as the degree to which such information is externally observable to stakeholders through corporate disclosure (Healy & Palepu, 2001, p. 406). Corporate disclosure allows firms to communicate information through regulated reports, voluntary communication channels, and other corporate reports (Healy & Palepu, 2001, p. 406). Building on the visibility concept used in disclosure research, visibility refers not only to whether information is present but also to whether it is prominent, comprehensible, accessible, and identifiable within specific reporting venues (Yang et al., 2024, pp. 266, 268). Therefore, this study analyzed which topics are disclosed, how they are represented, and whether they are explicitly anchored in references to NEA. The central research question is: *How does ecosystem service-related information become visible in corporate sustainability reporting and to what extent are such disclosures explicitly anchored in references to national ecosystem accounting?* To answer this question the study applies a quantitative content analysis of 2024 corporate reports from DAX companies, following prior content-analytic research on corporate environmental and sustainability reporting and the methodological logic of systematic content analysis (Borgstedt et al., 2019; Krippendorff, 2018; Schwoy et al., 2025; Singhania et al., 2025). The analysis examines which ecosystem service topics are addressed, how such information is represented (qualitative, physical, monetary, or analytical), and whether references to NEA concepts are apparent. By doing so, the study does not simply ask whether firms disclose nature-related information, but whether ecosystem service-relevant disclosures exhibit patterns that can be interpreted as being closer to, or more distant from, NEA-based forms of environmental accounting.

The thesis contributes to the existing literature in three ways. First, it provides empirical evidence on the corporate visibility of ecosystem service-related information by showing which ecosystem service-related topics appear in corporate sustainability reporting and in which representational forms. This extends prior studies on sustainability reporting that examined the thematic presence, frequency, and communication of environmental information, particularly climate, emissions, and biodiversity topics (Borgstedt et al., 2019; Cubilla-Montilla et al., 2020; Miklosik & Evans, 2021; Papafloratos et al., 2023; Taşoğlu et al., 2024). The thesis also builds on recent visibility-oriented disclosure research by applying the concept of visibility to ES-related information rather than to climate-related disclosures alone (Yang et al., 2024). Second, it contributes to research at the intersection of sustainability accounting, ecosystem accounting, and natural capital accounting by examining whether and to what extent corporate disclosures are explicitly anchored in references to NEA. This contributes to studies discussing the potential alignment between biodiversity, ES, business sustainability, and public environmental accounting, while also highlighting the persistent gap between macro-level accounting systems and firm-level sustainability practices (D'Amato et al., 2024; Grunewald et al., 2024; Singhanian et al., 2025). Third, it advances the understanding of the relationship between NEA and corporate sustainability reporting by highlighting the translation challenge between standardized environmental accounting frameworks (such as SEEA EA, NEA, ES accounts, and natural capital accounts) and firm-level disclosure practices. Thus, the thesis contributes not only to the literature on sustainability reporting, but also to the broader discussion of how environmental accounting information becomes translated, simplified, or selectively adopted when it enters organizational reporting contexts.

The remainder of this thesis is structured as follows. The next section outlines the theoretical background and reviews the relevant literature, beginning with NEA as the central accounting framework underlying this study. Section 3 describes the data, sample, and methodological approach. Section 4 presents the empirical findings and Section 5 discusses the results, highlights their implications, and concludes the thesis.

2. Theoretical Background and Literature Review

2.1. National Ecosystem Accounting

National Ecosystem Accounting (NEA) refers to the integration of ecosystem services and ecosystem assets into national accounting systems (Edens & Hein, 2013, p. 41). In practice, NEA includes accounts that record the extent of forests, wetlands, grasslands, rivers, and other ecosystem types, assess their conditions, and link these ecosystem assets to the services they provide (Bruzón et al., 2022, p. 2; Edens et al., 2022, pp. 2–3; King et al., 2023, p. 2,4). For example, a forest account could document the amount of forest land in a country, its ecological condition, and its contribution to services such as carbon sequestration, timber production, water regulation, and recreation (Edens et al., 2022, pp. 2–3; King et al., 2023, p. 4; Vallecillo, La Notte, Zulian, et al., 2019, p. 197). Similarly, a wetland account may record the spatial extent and condition of wetlands and link these assets to services such as flood regulation, water purification, biodiversity support, and recreational use (Bruzón et al., 2022, p. 2; Farrell et al., 2021, p. 5; Warnell et al., 2020, pp. 2–3). These accounts provide a comprehensive measurement system that captures the physical and monetary expression of ecosystem services and ecosystem assets within a structure based on the concepts of the System of National Accounts (SNA) (Obst et al., 2016, p. 9). The SNA is an internationally standardized framework for national accounts that specifies how economic activities and assets are measured and presented consistently and comparably across countries (Moulton, 2004, p. 261). Unlike selective assessments, NEA aims to structure information comparably and comprehensively over time, for instance by repeatedly measuring changes in ecosystem extent, ecosystem condition, ecosystem service flows, and ecosystem asset values (Comte et al., 2022, p. 2; Edens et al., 2022, p. 2; Obst et al., 2016, p. 12). In principle, this makes NEA a potentially relevant source of structured environmental information not only for public policy, but also for organizations seeking to contextualize ecosystem-related dependencies and impacts.

The development of this accounting approach spans more than four decades within the broader field of natural capital accounting (Obst et al., 2016, p. 2). In response to growing environmental concerns, early forms of “green accounting” emerged in the 1970s (Obst et al., 2016, p. 2). A major milestone followed in 1993, when the United Nations (UN) published the first System of Environmental-Economic Accounting (SEEA) manual as an international standard (Edens et al., 2022, p. 2; Obst et al., 2016, p. 3). However, the SEEA Central Framework focused primarily on individual natural resources such as gas or oil and did not yet capture ecosystems as integrated functional systems (Comte et al., 2022, p. 2). To address this limitation, the SEEA

Experimental Ecosystem Accounting (SEEA EEA) was introduced in 2013. This framework was designed to capture the complex interactions of ecosystems as functional units (Comte et al., 2022, p. 2; Edens et al., 2022, pp. 2–3). In March 2021, the UN Statistical Commission officially adopted the SEEA Ecosystem Accounting (SEEA EA) manual as an international statistical standard (Edens et al., 2022, p. 1). Figure 2 summarizes the historical development.

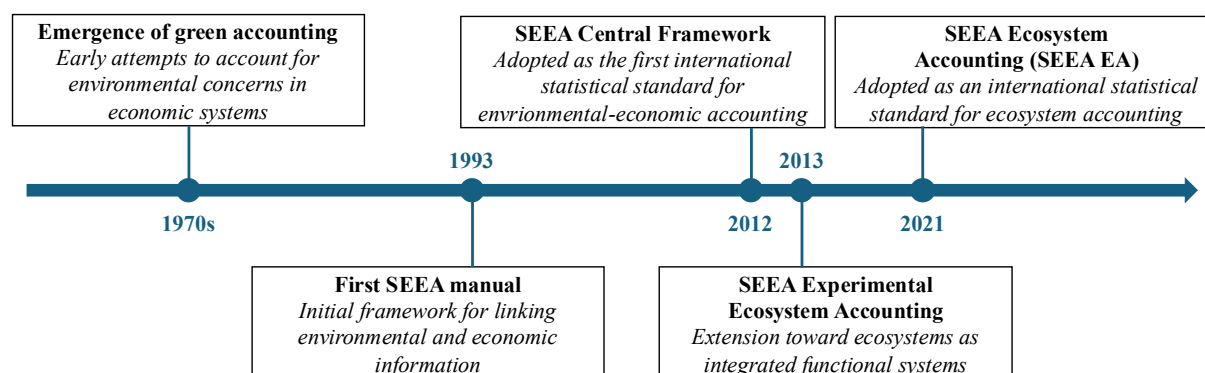


Figure 2: Development of environmental-economic and ecosystem accounting

The main purpose of NEA is to make the contributions of ecosystems to human well-being and the economy visible that are often overlooked by conventional indicators such as GDP (Bruzón et al., 2022, p. 2; Hein et al., 2020, p. 514; Warnell et al., 2020, p. 2). More specifically, ecosystem accounting is intended to support measurement beyond GDP and to provide indicators that enable more sustainable forms of economic planning and decision-making (Edens et al., 2022, pp. 1, 5–6). In addition, it can support the monitoring of international goals such as the Sustainable Development Goals (SDGs), the analysis of trade-offs between costs and benefits of alternative land-use scenarios, greater transparency and fairness in regulation, and more informed risk management (Bordt & Saner, 2018, p. 1; Bruzón et al., 2022, p. 1; Edens et al., 2022, p. 2,5; Hein et al., 2020, p. 514; Keith et al., 2017, pp. 1683, 1688; King et al., 2023, p. 2; Warnell et al., 2020, p. 2).

The framework consists of five core accounts as well as supplementary thematic accounts. Ecosystem Extent Accounts record the geographic area of different ecosystem types within a given region (Bruzón et al., 2022, p. 2; Edens et al., 2022, p. 2; King et al., 2023, p. 2). Ecosystem Condition Accounts assess the quality and integrity of ecosystems on the basis of their biotic and abiotic characteristics, which can be measured through indicators such as species diversity or water quality (Farrell et al., 2021, p. 5; Vačkářů & Grammatikopoulou, 2019, p. 38). Ecosystem Services Account and Ecosystem Supply Use Accounts record the flow

of services from ecosystems as providers to people and the economy as users (King et al., 2023, p. 2; Vallecillo, La Notte, Zulian, et al., 2019, p. 197). These accounts can be compiled in both biophysical units (e.g., tons) and monetary units (Edens et al., 2022, p. 2; Vallecillo, La Notte, Zulian, et al., 2019, p. 197). Ecosystem Monetary Asset Accounts assess the total monetary value of ecosystem assets (Edens et al., 2022, p. 2; King et al., 2023, p. 2). They capture changes in value resulting from changes in extent or condition, as well as from price changes during the accounting period (Edens et al., 2022, p. 2; Obst et al., 2016, p. 12). Finally, Thematic Accounts are supplementary topic-specific accounts that complement the five core accounts and are designed to address particular policy questions, for example carbon accounting in support of climate policy (Hein et al., 2020, p. 514; King et al., 2023, p. 2; Warnell et al., 2020, p. 3).

Although NEA is primarily designed for national-level statistics and public policy, its categories and outputs are also potentially relevant for corporate reporting. They can provide contextual information on ecosystem dependencies, environmental conditions, and service flows that companies may use to frame or substantiate sustainability-related disclosures. At the same time, this potential relevance does not imply straightforward applicability. NEA operates at a macro level and follows an accounting logic that is not automatically aligned with firm-level reporting boundaries, materiality assessments, or disclosure routines. (Grunewald et al., 2024, pp. 21, 26–27, 29–30). This tension is central to the present thesis. Within this context, ecosystem services are particularly important because they form the central conceptual link between NEA and the environmental topics addressed in corporate sustainability reporting.

2.2. Ecosystem Services

Ecosystem services (ES) are generally understood as the benefits that humans derive from ecosystems (Baskent, 2020, p. 1; Chen et al., 2023, p. 1; Small et al., 2017, p. 58). For example, forests can provide timber and other raw materials, regulate the climate through carbon sequestration, contribute to water regulation, and offer recreational opportunities (Baskent, 2020, p. 6; Millennium Ecosystem Assessment, 2005, p. 40). Wetlands can provide services by reducing flood risks, filtering water, supporting habitats, and enabling recreational use (Baskent, 2020, p. 6; Millennium Ecosystem Assessment, 2005, p. 40). Urban green spaces can also be understood through an ES lens because they can contribute to air regulation, temperature regulation, recreation, and aesthetic value for local communities (Baskent, 2020, p. 6; Millennium Ecosystem Assessment, 2005, p. 40). The Millennium Ecosystem Assessment (MEA) describes them as “the functions and products of ecosystems that benefit humans or

promote social well-being” (Lele et al., 2013, p. 343; Millennium Ecosystem Assessment, 2005). Across different definitions, the central common element is therefore the explicit link between ecological systems and their contribution to human well-being (Baskent, 2020, p. 1). The literature contains some variation on how exactly ES are delimited. Some approaches define them broadly and include ecological functions and processes that affect human well-being, whereas others, especially in more economic interpretations, focus more narrowly on the final service flows from ecological assets (Danley & Widmark, 2016, pp. 134–135; La Notte et al., 2017, p. 397).

The concept of ES originally gained prominence because it addressed the economic invisibility of nature and emphasized human dependence on ecological systems (Baskent, 2020, p. 2; Hejnowicz & Rudd, 2017, p. 10). It is intended to make the contribution of nature to human well-being more visible and, where possible, measurable in order to support political and economic decision-making (Allan et al., 2022, p. 62; Baskent, 2020, p. 1). In this sense, ES function as a boundary object that facilitates communication across disciplines such as ecology and economics despite their different analytical perspectives (Kull et al., 2015, pp. 126, 128).

For the purpose of a content analysis, a classification of ecosystem services is necessary to establish analytical comparability. However, there is no universally applicable typology suitable for all purposes. The choice of classification depends largely on the decision context (Czúcz et al., 2018, p. 146; Fisher et al., 2009, pp. 643, 651). The most common and general typology is the one associated with the MEA classification which is divided into four main categories (Fisher et al., 2009, p. 644; Millennium Ecosystem Assessment, 2005). Provisioning services refer to the supply of material resources, such as food, water, wood, and fibers. Regulating services comprise those functions that stabilize environmental conditions and mitigate risks, for example climate regulation, flood protection, and water purification. Cultural services describe non-material contributions such as recreation, aesthetic values, and spiritual fulfillment. Finally, supporting services include the underlying processes that enable the provision of other services, such as soil formation, nutrient cycles, and primary production (Baskent, 2020, p. 6; Millennium Ecosystem Assessment, 2005, p. 40).

An alternative classification system is the Common International Classification of Ecosystem Services (CICES). In contrast to MEA, CICES excludes supporting services because they are generally interpreted as underlying ecological processes rather than as services in themselves (Baskent, 2020, p. 6; Czúcz et al., 2018, p. 147; La Notte et al., 2017, p. 395). Their inclusion as services could lead to double counting in valuation, since these services generate or enable

other ES. In CICES, they are therefore treated as integral components of internal ecosystem functions rather than as a separate service category (Moreno et al., 2018, p. 884).

This thesis adopts the CICES classification, which is the appropriate choice because this framework is widely used in the European context for environmental and ecosystem accounting (Czucz et al., 2018, p. 147; La Notte et al., 2017, p. 395). This makes it more aligned with the NEA background of this study. Also, the exclusion of supporting services avoids conceptual overlap between ecological preconditions and final service-related contributions, which is helpful for maintaining coding clarity.

2.3. Sustainability reporting in Germany

Sustainability reporting refers to the practice through which companies measure and communicate their performance with regard to sustainability-related objectives and impacts (Agama & Zubairu, 2022, p. 32; Rusu et al., 2024, p. 1). It serves both as a management instrument and as an accountability mechanism by enabling companies to report transparently on the effects of their business activities to internal and external stakeholders, including investors, customers, and employees (Schwoy et al., 2025, p. 688; Sundarasan et al., 2025, p. 2). Unlike traditional financial reporting, sustainability reporting primarily covers ESG dimensions, that is, environmental, social, and governance issues (Rusu et al., 2024, p. 1, 3). Environmental reporting, for example, includes issues such as energy consumption and greenhouse gas emissions, social reporting addresses topics such as working conditions, human rights, and inclusion, and governance reporting covers areas such as governance structures, measures against corruption and bribery, and the independence of the board of directors (Rusu et al., 2024, p. 3; Wagenhofer, 2024, p. 7). Whereas financial accounting is based on aggregation and accrual accounting, sustainability reporting focuses on a large number of individual data points and is more forward-looking (Wagenhofer, 2024, pp. 1–2, 9). For example, companies need to disclose topic-specific indicators such as emissions by scope, energy use, water consumption, waste, workforce data, and governance-related metrics, as well as targets, transition plans, risks, opportunities, and expected future impacts (Balios, 2025, pp. 17–18; Rusu et al., 2024, p. 3). Another key feature is the inclusion of data from the entire value chain beyond the direct control of the reporting company (Wagenhofer, 2024, pp. 2, 6).

In Europe, including Germany, sustainability reporting is now shaped by the Corporate Sustainability Reporting Directive (CSRD) (Pitz et al., 2025, p. 263). This framework replaces and expands on the previous directive, the Non-Financial Reporting Directive (NFRD) and

applies in 2024 to all large capital market-oriented companies with more than 500 employees, which includes all DAX companies (Sharma, 2025, pp. 2–3, 6). The CSRD places sustainability reporting on a level more comparable to financial reporting (Fragidis & Papafloratos, 2025, p. 2). The overall aim is to improve the quality, comparability and reliability of sustainability-related information and thereby support more informed decision-making and the redirection of capital towards sustainable activities (Pitz et al., 2025, pp. 261, 267). Among the most important changes are the stronger emphasis on both sustainability impacts and financially relevant sustainability risks, the requirement for external assurance, and the obligation to provide sustainability information in a digital, standardized format (Raimo et al., 2025, p. 5; Sharma, 2025, p. 8).

To specify the content requirements of the CSRD, technical standards have been developed, one of them being the European Sustainability Reporting Standards (ESRS) (Balios, 2025, p. 17). Among them, the topical standards cover the three ESG dimensions of environment, social matters, and governance (Balios, 2025, p. 17). This thesis focuses specifically on the environmental dimension because it is here that the closest link to ES and NEA can be established. More specifically, the analysis covers the five environmental ESRS topics: climate change, pollution, water and marine resources, biodiversity and ecosystems, and resource use and circular economy (Balios, 2025, pp. 17–18).

2.4. Theoretical Frameworks

2.4.1. Issue selection and disclosure incentives

ES are diverse and sometimes difficult to define. They are also often only indirectly observable (Danley & Widmark, 2016, p. 133). Services such as carbon sequestration, water purification, pollination, flood regulation, soil formation, and habitat provision are not usually observed directly, as are energy consumption and greenhouse gas emissions. Rather, they are often inferred from ecological conditions, land-use patterns, scientific models, or proxy indicators (Danley & Widmark, 2016, pp. 133–135; La Notte et al., 2017, pp. 397, 399–401). This creates considerable variability in terms of which ES topics appear in corporate sustainability reports and which remain invisible. While the CSRD and the associated ESRS increase the pressure to disclose environmental information, companies still must decide which nature-related topics are relevant, how deeply to explore them, and in which reporting context to anchor them. This raises questions about the motivation behind their communication.

One theory is the stakeholder theory which posits that reporting is a response to the perceived information needs and interests of relevant stakeholders (Hariono et al., 2025, pp. 3807–3808). Regarding ES, the selection of performance disclosures in the report is primarily determined by stakeholder expectations and the materiality of environmental impacts (Vola et al., 2025, pp. 65, 67). A key criterion of the theory is shared risk. According to the theory, companies should report on environmental sustainability issues that could endanger both the company and its stakeholders such as environmental disasters or the depletion of natural resources. This also includes performance for which “implicit contracts” exist with society, such as the use of common goods, like clean water (Vola et al., 2025, p. 65). Additionally, the theory requires reports to focus on material impacts rather than arbitrarily covering all possible sustainability issues (Vola et al., 2025, p. 64). The selection is based on criteria such as power, urgency, and legitimacy of the stakeholders (Herremans et al., 2016, p. 420). Companies therefore report on the ES on which they have the greatest positive or negative impacts which means that less tangible or difficult-to-standardize ES aspects could more easily fall out of focus.

Additionally, legitimacy theory focuses on the social acceptance of companies (Lai et al., 2016, p. 166). Here, reporting does not primarily serve to provide data, rather it serves to secure a “social contract” in which companies attempt to align their activities with social norms and values (Akhter et al., 2023, p. 345; Borgstedt et al., 2019, p. 179). For ES this means that the selection of reported topics is strategically motivated to secure or restore social acceptance. Companies tend to report on ES topics with the greatest impact or highest public visibility in their industry (Zharfpeykan, 2021, p. 2210). There is a strong tendency to emphasize ES topics that enable proactive communication of responsibility, for example tree planting or investments in renewable energies, while potentially harmful impacts or neglected areas, for example climate funds, are more likely to be omitted (Akhter et al., 2023, pp. 344, 354, 358). At the same time legitimacy pressure may explain why reports appear dense in certain areas. When public expectations are high there is a greater incentive to highlight these achievements to meet current requirements (Borgstedt et al., 2019, pp. 179–180).

In summary, the stakeholder theory and legitimacy theory explain why certain nature-related topics are prioritized in reporting, mainly because they are prominent in regulatory or social debates. While other ES categories are ecologically significant, they are less firmly anchored in communication and more difficult to translate into standardized reporting templates. Although the CSRD and ESRS provide a structure, they still allow for prioritization, focus, and depth.

2.4.2. Institutionalization of reporting practices

ES and ecosystem accounting are caught between two conflicting demands in corporate sustainability reporting. On the one hand, the CSRD increases the requirement to disclose nature-related information in a more comparable and comprehensible manner. On the other hand, it is often unclear how exactly ES should be presented in reports (Boerema et al., 2017, p. 359). Questions and uncertainties like which categories are reportable and which key figures are considered acceptable are the central starting point of institutional theory. Rather than viewing reporting as the result of efficient information provision, institutional theory explains it as a process of institutionalization. Companies adopt practices, structures, and language patterns considered legitimate, professional, and expected in their environment (Herold, 2018, p. 8; Posadas et al., 2023, p. 28). This perspective is particularly relevant to this thesis because it explains why reporting practices on ES can converge despite heterogeneous business models. These convergences can be seen in the choice of topics, the form of presentation, the depth of information, and the use of external evidence sources, such as SEEA EA.

Institutional theory essentially argues that organizations are pressured to report in a manner that is essential for their long-term superiority (Herold, 2018, p. 8). This institutional pressure (isomorphism) can come from various sources and is often described as coercive, normative, or mimetic (Amoako et al., 2021, p. 2; Bhuiyan et al., 2023, p. 4220). When facing coercive pressure companies primarily report to comply with legal requirements and avoid sanctions (Cubilla - Montilla et al., 2020, p. 1184). For German companies laws such as the CSRD act as coercive mechanism obliging companies to disclose information on environmental issues. In reporting this means that environmental and nature-related topics become less of a freely configurable communication space and more of an area in which certain topics, processes, and information are expected (Posadas et al., 2023, pp. 28–29). Normative pressure stems from adhering to standards and norms considered legitimate by society (Amoako et al., 2021, p. 3). In this context, ecosystem accounting frameworks such as SEEA EA can appear legitimate because they offer a standardized language. Finally, mimetic pressures describe imitation under uncertainty (Amoako et al., 2021, p. 3). When companies are unsure how to address an issue they model their behavior after successful or leading competitors (Ding & Wang, 2025, p. 3). They model their reports on those of industry leaders to increase their own legitimacy and minimize the risk of poor public perception (Martínez-Ferrero & García-Sánchez, 2017, p. 105). This is particularly evident in new areas, such as biodiversity and ecosystem services, where clear guidelines are still being developed (Amoako et al., 2021, p. 3).

In summary, according to institutional theory, reporting on ES is less about providing objective information and more about gaining social legitimacy by conforming to legal, professional, and competitive expectations. The mechanism of isomorphism explains the similarity of ecosystem-related reporting and why improvements in quality often depend more on normative and mimetic dynamics than on regulation alone.

2.4.3. Information adoption and data use

Although companies are incentivized to report on ES and reporting practices have the tendency to be more standardized and imitated through regulation and standards, the question of whether actual sustainability reporting is based on robust external evidence bases, such as data and outputs from the SEEA EA or if it is predominantly based on qualitative, generally formulated statements arises. Two complementary theoretical perspectives explain the mechanisms by which external data is found, understood, and translated into a reporting logic: information processing theory and decision usefulness theory, as well as absorptive capacity.

A key starting point is recognizing that organizations cannot absorb and process information indefinitely. According to information processing logic, external data is only integrated if it is perceived as useful for making decisions (Reimsbach et al., 2018, p. 563). In the context of ES, information such as that provided by SEEA EA can be helpful to establish the context of nature-related risks and dependencies. However, many SEEA EA outputs are aggregated at the national level whereas companies operate in specific locations (Grunewald et al., 2024, p. 29; Obst et al., 2016, p. 9). Before such data can be considered relevant in decision-making it must be translated into company-specific logic (Farrell et al., 2021, p. 27). From a decision-usefulness perspective, if this effort is too great, companies may resort to general qualitative statements rather than using or referencing external accounts (Esch et al., 2019, p. 601).

However, just because external data appears relevant it does not mean it will be adopted by the company. This is where the absorptive capacity perspective comes in. This perspective emphasizes that the use of external information depends on organizational capabilities. Data and knowledge about ES must be obtained, understood, transformed and put to practical use (Hara & Choi, 2025, p. 49). The process comprises the dimensions acquisition, assimilation, transformation, and exploitation (Hara & Choi, 2025, p. 49). Simply acquiring data requires organizations to identify relevant sources such as national nature capital accounts, biodiversity indicators, and environmental statistics and to consider them critical to their operations (Cooper & Molla, 2017, p. 390; Dzhengiz & Niesten, 2020, p. 885). Then, assimilation requires

expertise to correctly interpret concepts such as service flows or valuation assumptions and contextualize them within the organization (Dzhengiz & Niesten, 2020, p. 885). During the transformation phase, external information must be translated into existing internal categories that can be used for reporting purposes, such as ESRS-related topic grids (Cooper & Molla, 2017, p. 390; Dzhengiz & Niesten, 2020, p. 889). Finally, exploitation means the translated information actually flows into management and reporting practices such as KPIs, target systems, and analyses (Cooper & Molla, 2017, p. 390; Dzhengiz & Niesten, 2020, p. 885).

Absorptive capacity plays a key role in how companies report on ES. It bridges the gap between theory and practice, establishes a foundation for proactive strategies, and closes information gaps. When absorptive capacity is weak ES tends to remain peripheral and symbolic in reporting, whereas high environmental absorptive capacity helps build environmental capabilities and sustainable performance (Dzhengiz & Niesten, 2020, p. 889).

2.4.4. Commensuration and calculative practices

The previous mechanisms explained why companies initially choose environmental topics, how reporting practices are shaped by regulations and standards, and why although external data sources, such as SEEA EA, are available they only become usable once processed by the organization. The next step addresses how ES appear in the report. This is where the mechanism of commensuration and calculative practice come into play.

This mechanism explains how companies translate complex environmental references into comparable, manageable information and how they enact it. For reporting on ES this means a common metric must be created using technical tools and instruments to make it calculable and tangible for management. The simplest solution is quantitative representation. This form is primarily used to document the current condition and extent of ecosystems (La Notte et al., 2022, p. 2). It also forms the basis for further assessments by measuring physical flows, for example, cubic meter for wood or tons of sequestered CO₂ (Vallecillo, La Notte, Ferrini, et al., 2019, p. 2). Quantitative data is often used when monetary values are too uncertain or when the primary goal is to monitor ecological integrity (Vallecillo, La Notte, Ferrini, et al., 2019, p. 13). Deeper forms of commensuration include monetary and analytical representation. Monetary representation occurs when ES are directly linked to financial impacts such as avoided water purification costs or the market price of carbon credits (Pelletier et al., 2025, pp. 72–73, 80). This is useful when a company wants to communicate the importance of nature to financial stakeholders using their logic (Pelletier et al., 2025, p. 61). According to the SEEA EA, for

example, monetization is used in accounting to represent the net present value of future performance flows as a stock variable (La Notte et al., 2022, p. 2). Reporting becomes analytical when it goes beyond a mere inventory and models scenarios or trade-offs (Meraj et al., 2022, p. 29). This approach is useful for predicting how future management decisions will affect the future provision of services, for example, through methods like the comparison of business-as-usual scenarios with an optimal scenario (Pelletier et al., 2025, pp. 71, 80).

In summary, commensuration and calculative practices make ES countable in corporate and public accounting by translating them into standardized biophysical or monetary and analytical metrics. When robust ES data, models, and assessment methods are available that are consistent with accounting frameworks companies can report on ES quantitatively, monetarily, and analytically.

2.5. Literature Review

2.5.1. Which ecosystem service topics are disclosed

The empirical literature on corporate sustainability reporting reveals a consistent pattern across industries, countries, and methodological designs. Studies based on Global Reporting Initiative (GRI) indicator analysis, environmental target coding, sector-specific materiality assessments, and semantic keyword analysis show that topics related to climate, emissions, and energy tend to be particularly visible in corporate sustainability reporting, whereas biodiversity-related topics and other complex environmental issues are often less prominent (Borgstedt et al., 2019; Cubilla-Montilla et al., 2020; Miklosik & Evans, 2021; Papafloratos et al., 2023; Taşoğlu et al., 2024; Tiscini et al., 2022). This suggests that companies primarily address environmental issues that can be expressed in measurable performance indicators and generate significant stakeholder, regulatory, or reputational attention.

Several studies show that compared to other environmental areas, emissions and energy aspects dominate in sustainability reporting. Using 34 Global Reporting Initiative (GRI) environmental indicators Cubilla-Montilla et al. analyzed corporate social responsibility and sustainability reports and showed that the average disclosure rates are highest in the emissions and energy categories (Cubilla - Montilla et al., 2020, pp. 1185, 1188). Within these categories, indicators related to energy consumption within the company and direct and indirect greenhouse gas emissions (Scope 1 and 2) are reported most frequently (Cubilla - Montilla et al., 2020, p. 1188). Meanwhile, biodiversity-related indicators were reported significantly less frequently in

the sample indicating a systematic focus on energy- and emissions-related content (Cubilla-Montilla et al., 2020, pp. 1191–1192).

This pattern is also evident in studies that do not focus primarily on GRI indicators but rather on reported targets, topic clusters, or semantic frequencies. Borgstedt et al. coded environmental targets in the corporate environmental reports of German DAX companies over a long period and found that energy-related categories and greenhouse gas emissions repeatedly appeared in the top three topic areas of individual companies (Borgstedt et al., 2019, pp. 178, 186, 188–189, 191). These categories were simultaneously framed as particularly relevant to stakeholders (Borgstedt et al., 2019, p. 192). Companies' treatment of energy and emissions as particularly legitimacy-relevant topics is also evident in Borgstedt et al.'s discussion of communication strategies such as highlighting certain aspects (e.g., renewable energies) in these areas because high expectations and reputational risks are assumed here (Borgstedt et al., 2019, pp. 191–192).

Sector-specific evidence also supports the dominance of climate- and emissions-related reporting. Papafloratos et al. examined materiality disclosures by the largest chemical companies and found that climate change was most frequently reported as material (Papafloratos et al., 2023, pp. 7, 10, 17). These reports explicitly operationalized climate change in terms of CO₂ and greenhouse gas emissions and reduction targets (Papafloratos et al., 2023, p. 10). In the same study other environmental issues such as pollution, water, waste, and energy are also frequently mentioned as material but lag behind climate issues suggesting a clear hierarchy within environmental reporting (Papafloratos et al., 2023, pp. 10–11, 17). Taşoğlu et al.'s comparative frequency coding study of the airline industry reveals that statements on climate change and emission reduction are particularly prominent and are among the most frequently coded topics in several cases (Taşoğlu et al., 2024, pp. 5, 8, 10). The authors also report that energy efficiency and greenhouse gas reduction measures are recurring top categories in the annual reports of the examined airlines confirming the central importance of emissions and energy even in an emission-intensive industry (Taşoğlu et al., 2024, pp. 18–19).

A semantic perspective on report narratives and term frequencies provides a complementary view. Tiscini et al. demonstrate that in sustainability reports from two different time periods terms such as “GHG emissions” and “CO₂ emission” occur significantly more frequently in the latter period (Tiscini et al., 2022, p. 898). At the same time, topic clusters related to the environment and environmental impacts gain relevance indicating a stronger focus on emissions-related impact logics (Tiscini et al., 2022, p. 898).

Although they are methodologically different, the findings from the study from Miklosik & Evans who structure reports on keywords and their occurrence is comparable in terms of content. The authors designed their keyword list using GRI logic (Miklosik & Evans, 2021, p. 4). They found that the terms environment, climate, emissions, and carbon footprint appeared most frequently in their sample (Miklosik & Evans, 2021, pp. 5–6). Emissions-related mentions typically appeared in contexts related to CO₂ or carbon emissions which underscores the semantic visibility of emissions-related content (Miklosik & Evans, 2021, p. 4).

Overall, based on the empirical evidence it can be expected that companies will primarily address climate-related regulatory content in their environmental reporting. This content can be operationalized via greenhouse gas emissions, decarbonization, energy consumption, and efficiency measures. It is most frequently reported using multiple designs while biodiversity-related environmental aspects are reported less frequently on average.

2.5.2. How ecosystem service topics are disclosed

The literature on corporate reporting of ES paints a consistent picture. Although companies are addressing the issue more frequently, their reporting is still mostly descriptive and rarely uses standardized, comparable metrics (Grunewald et al., 2024, pp. 18, 40). A key reason for this is that ES are often difficult to measure and quantify directly meaning that indicators can typically only be used as proxies. (Grima et al., 2023, pp. 1–2). Even then, not all services can be operationalized in the same way. This measurement problem is evident in application-oriented research which reveals a significant amount of methodological heterogeneity in the indicators employed (Veerkamp et al., 2021, p. 1). While many approaches quantify ecological characters, the actual benefits, value attributions, and social demands of humans are less frequently presented (Veerkamp et al., 2021, pp. 1, 7).

Monetary or standardized quantifications are also possible in research, but they require extensive assumptions, data harmonization, and methodological decisions as demonstrated, for example, in meta-analyses that convert values into uniform units while at the same time identifying significant variations and drivers of value differences (Taye et al., 2021, pp. 2, 9–10). In the context of national or macroeconomic anchoring such quantifications are sometimes explicitly translated into accounting logic. For example, value transfer approaches for “start-up accounts” are discussed and supply and use tables are presented as a possible form of illustration (Grammatikopoulou & Vačkářová, 2021, pp. 1, 8, 10). At the same time, it is emphasized that the lack of guidelines and inconsistent reporting methods in primary studies make accounting application difficult (Grammatikopoulou & Vačkářová, 2021, p. 10). More recent approaches

illustrate that a uniform standard for valuing or accounting for ES has not been established. Method-dependent differences can be considered which limits comparability and routine application further (Li et al., 2023, pp. 1, 8, 10). Against this backdrop Grunewald et al. argue that, in practice, companies often fail to reflect the full analytical depth of quantification approaches. Instead, they reduce their reporting to forms that are practical, understandable to the target audience, and compatible with regulatory requirements (Grunewald et al., 2024, pp. 21–22, 24).

Empirical evidence on corporate disclosure practices show that environmental information appears in various formats in reports. Narrative disclosures are a relevant component, and quantitative or monetary disclosures do not consistently dominate (Akhter et al., 2023, pp. 353, 357). This indicates that disclosure practices tend to be qualitative in nature overall. At the same time, the literature on sustainability emphasized that corporate practices often fail to address environmental and natural issues consistently using a natural capital approach. Instead, data is used selectively and without sufficient context. A coherent quantification of ES and associated dependencies continues to lack a uniform approach (D’Amato et al., 2024, p. 1032). The distinction between NEA and corporate sustainability reporting is described as structurally significant. National systems aim for detailed, location-specific, and methodologically standardized accounts, whereas corporate reporting works with consolidated indicators, representing a significant simplification compared to national reporting (Grunewald et al., 2024, pp. 21, 26–27, 29–30). Additionally, it is argued that although macro-micro coherence in the logic of natural capital accounting could be achieved in principle, corporate sustainability accounting is not often interpreted in this strictly compatible manner in science and practice which tends to make direct references to official national ecosystem or environmental accounts unlikely in corporate practice (D’Amato et al., 2024, pp. 1032, 1039).

2.6. Synthesis and Hypotheses Development

The thematic focus observed in environmental reporting cannot be understood solely as a descriptive finding. Rather, it can be theoretically explained as to why companies prioritize certain environmental issues while others remain comparatively marginal. Empirical studies consistently demonstrate that emissions- and energy-related content, as well as climate issues, have above-average visibility in various industries, countries, and methodological operationalizations. In contrast, biodiversity-related or less standardized environmental aspects are significantly less visible. Theoretically, this dominance can be explained by the fact that

companies intensify their reporting primarily in areas where external stakeholders have high expectations and enable comparisons, thus generating noticeable pressure.

Herold explicitly argues that as an organizational field of action sustainability reporting is shaped by stakeholder and institutional influences (Herold, 2018, p. 6). Climate change in particular is a topic under close stakeholder scrutiny (Herold, 2018, p. 7). Following this logic, Borgstedt et al. demonstrate that the context of corporate environmental reporting disclosure is closely linked to stakeholder expectations (Borgstedt et al., 2019, p. 177). This is because stakeholders control resources and companies use communication to secure legitimacy and reputation which are critical resources (Borgstedt et al., 2019, p. 178). Thus, the accumulation of climate- and emissions-related content is consistent with the assumption that these topics are salient because they can easily be observed and compared by relevant stakeholder groups.

This mechanism is linked to legitimacy as a translation logic which explains why companies report more selectively, focusing on issues considered critical to legitimacy in public disclosure. Herold emphasized that legitimacy is the primary rationale for sustainability reporting and that due to intense public debate climate change is particularly well-suited for addressing legitimacy requirements through communication (Herold, 2018, p. 8). The selectivity of reporting about climate and emissions frequently observed empirically is therefore no coincidence. It is consistent with the assumption that companies primarily address legitimacy where perception risks and potential sanctions are considered high (Akhter et al., 2023, p. 346).

This selectivity is further reinforced institutionally by the fact that reporting practices align under coercive, normative, and mimetic forces of isomorphism, thereby creating legitimate agendas in the organization field (Posadas et al., 2023, p. 28). Consequently, environmental aspects highly compatible with standards, industry conventions, and assurance logic are more likely to be widely and repeatedly reported while less institutionalized topics appear less frequently and in a more fragmented manner.

Against this backdrop, it is theoretically plausible to predict the dominance of climate-related reporting as an expected outcome of this thesis because climate change, and emissions in particular, emerge as central environmental issues relevant to legitimacy and stakeholders in various contexts. This leads to the following hypothesis which links the empirical findings with the theoretical rationale:

H1: In corporate sustainability reporting ecosystem service-related information is disclosed selectively with climate change being addressed more frequently than other ecosystem service-related topics.

The prevalence of qualitative statements about ES in the literature, coupled with the rarity of explicit references to national, official, environmental, or ecosystem accounts, can be interpreted as a consistent result of limited processing capacities and selective benefit expectations during the reporting process.

From a commensuration and calculative-practices perspective qualitative dominance is expected because converting heterogeneous ES into comparable numbers presupposes stable measurement conventions (Boerema et al., 2017, pp. 358, 361). ES quantification is characterized by highly diverse and often weakly validated indicators which constrains comparability and thus the feasibility of commensuration in reporting practice (Boerema et al., 2017, pp. 358, 361).

From an information-processing perspective the observed preference for narrative and simplified forms of presentation is consistent with the fact that reporting on ES often requires substantial data, modeling, and contextualization. Therefore, companies tend to use communication formats that are less cognitively demanding. According to findings from accounting research, this logic is consistent with the idea that display and presentation formats influence information processing through different cognitive costs (Reimsbach et al., 2018, p. 563). These costs make it more difficult to simultaneously grasp several pieces of information that are spatially or structurally distributed, particularly in the case of limited, short-term working memory capacity (Reimsbach et al., 2018, p. 563).

This reduction to practical formats is described in the literature as an expected practice because companies often do not reflect the analytical depth of scientific quantification approaches. Thus, the empirically visible qualitative dominance is not only a deficit in measurement but also a form of complexity management resulting from the tension between information requirements and processing capacities. This expectation is reinforced by decision-usefulness-oriented logic because the usefulness of reported information depends on whether the recipients can process and translate it into decisions. The heterogeneity of monetary valuation approaches documented in the literature as well as their strong dependence on assumptions suggests that companies often find it more beneficial to use communicable narratives for decision-making. Consequently, it is reasonable to assume that quantitative or monetary information tends to be selective rather than representative of the primary reporting method.

The following hypothesis can be derived from this theory-driven embedding of the literature and empirical findings:

H2: Ecosystem service-related information is represented more frequently in qualitative form than in physical, monetary, and analytical form

This reasoning also logically deduces the question of why companies rarely refer explicitly to national or official accounting systems. Although these systems provide highly standardized quantification logic, their structural logic and aggregation cannot easily be translated into company-specific relevant information requirements. Even when official statistics are available, ecosystem accounting requires the contributions of the ES from the human inputs included in SNA products (Vallecillo, La Notte, Ferrini, et al., 2019, pp. 3–4). While this shortcut can simplify accounting it is explicitly described as assumption-dependent and subject to uncertainty. At this point, absorptive capacity becomes the central connection point because the lack of explicit account references is also consistent with the fact that companies can perceive external knowledge resources for nature assessment, but their absorption, translation, and routine use can fail due to data infrastructures, competencies, and internal processes (Cooper & Molla, 2017).

This reinforces the argument that companies tend to choose qualitative representations and refrain from making explicit references to national accounts given the high level of complexity and limited absorptive capacity. Both reduce the cognitive and organizational requirements of reporting and stabilize the perceived decision-making benefits for the addressees. Following this logic, the third hypothesis is:

H3: Corporate sustainability reports rarely include explicit references to NEA as a source framework for ecosystem service-related disclosures

3. Data and Method

3.1. Data and Sample Description

The empirical basis of this thesis consists of publicly available corporate reports which serve as the material for the quantitative content analysis. The population of interest comprises companies operating within the EU reporting context that are affected by the CSRD and therefore face the introduction of harmonized ESRS requirements (Pitz et al., 2025, p. 262). The CSRD is intended to reduce fragmented disclosure practices and to enhance comparability and standardization through the ESRS, making it an appropriate regulatory backdrop for examining current reporting patterns (Sharma, 2025, p. 8).

To ensure a high level of codability and cross-company comparability, this thesis deliberately narrows the sample to DAX companies. Prior content-analytic research has likewise focused on DAX firms because company size and industry are important determinants of environmental disclosures, and large listed firms typically provide more regular and more structured reporting outputs (Borgstedt et al., 2019, p. 178; Braasch & Velte, 2023). In addition, DAX firms are frequently used to study advanced disclosure practices in Germany because they face comparatively strict reporting expectations and strong stakeholder pressure which increases the likelihood of substantive documented sustainability information (Braasch & Velte, 2023, p. 927). At the same time, the composition of the DAX still provides meaningful sectoral heterogeneity which makes it possible to analyze differences in disclosure logics across industries while retaining an otherwise broadly comparable reporting setting (Borgstedt et al., 2019a, p. 181). Sector classification for each firm is taken from the LSEG database (“NAICS Sector Name”) in order to capture industry variation in the evaluation.

The reports are manually collected from the official corporate websites of the respective DAX companies. The investor relations, sustainability, and reporting sections of each company’s website are searched to identify the most recent report covering the 2024 reporting year. If several report formats are available the report representing the company’s primary sustainability reporting output for the year is selected, such as a sustainability report, non-financial report, integrated report, or annual report with a dedicated sustainability section. The downloaded reports are stored in PDF format. The reports were collected between October and November of 2025.

The sample procedure follows transparent inclusion criteria commonly applied in content-analytic research based on corporate reports. Documents are included only if they are available

on company websites and provided in stable report formats such as PDF, because web-only disclosures may change over time and do not necessarily follow a consistent annual publication logic (Borgstedt et al., 2019, p. 182). The reporting year is set to 2024 in order to capture reporting practice at a key transition point, as companies prepare for CSRD-aligned reporting and the harmonization objective associated with the ESRS. To increase linguistic consistency in the coding process, only English-language report versions are used where available. The analysis includes the primary sustainability report of each company, with one report selected per firm (Schwoy et al., 2025, pp. 671, 676).

The final sample therefore comprises 40 companies and 40 reports (Table A1 in Appendix).

3.2. Research Design and Method

This thesis aims to capture the corporate visibility of ES-related information and NEA-related disclosure patterns in corporate sustainability reporting. Specifically, it addresses the following research question: *How does ecosystem service-related information become visible in corporate sustainability reporting and to what extent are such disclosures explicitly anchored in references to national ecosystem accounting?* To answer this question this study employs a quantitative content analysis based on Krippendorff's methodology (Krippendorff, 2018).

The analysis is based on the coding of text passages from corporate reports using a rule-based category system, or codebook. The codebook specifies which text signals are relevant to the research question and how they should be consistently classified across documents. The categories are developed deductively from the thesis's analytical focus. They are designed to identify observable reporting-level manifestations of ES-related information and to determine whether such disclosures are explicitly connected to NEA-related reference frameworks rather than to explore reporting practices inductively. To strengthen consistency, the category system is tested through pilot coding and subsequently refined by adding decision rules and examples where necessary in order to reduce ambiguity and interpretive discretion.

After coding the recorded information is transferred into a structured Excel dataset as binary indicators (present/absent). This approach is suitable for the thesis's objective of identifying patterns, frequencies, and cross-firm differences in the visible reporting level treatment of ES-related information and NEA-related references. At the same time, the binary operationalization provides a transparent and replicable procedure that can be consistently applied to extensive reporting documents.

Following Krippendorff's procedural logic of content analysis the research process is structured into six steps: unitizing (chapter 3.3), sampling (chapter 3.4), recording/coding (chapter 3.5), reducing (chapter 3.6), inferring (chapter 4), and narrating (chapter 5) (Krippendorff, 2018, pp. 87–90).

3.3. Step 1: Unitizing

The definition of units distinguishes between three central unit types in content analysis: sampling units, recording (or coding) units, and content units (Krippendorff, 2018, pp. 88, 103–107). Sampling units are the units from which the material for analysis is drawn (Krippendorff, 2018, pp. 103–104). In this thesis, these are the company reports of the companies examined. Specifically, the dataset comprises 40 reports from DAX companies for the 2024 reporting year with one report selected for each company.

The second unit type consists of recording (or coding) units, that is, the textual units on which the actual coding is performed (Krippendorff, 2018, pp. 104–105). In this thesis, paragraphs are defined as recording/coding units. A paragraph is understood as a text segment delimited by the layout that contains a coherent statement which is typically marked by a paragraph break. The choice of the paragraph level for the purpose of investigation is based on a study by Schwoy et al. who also use paragraphs as units of analysis and resort to single sentences only where necessary (Schwoy et al., 2025, p. 675). Operationally, this means that each paragraph is examined to determine whether it contains content corresponding to one or more relevant categories in the codebook and is coded accordingly. If a paragraph contains several relevant elements, multiple coding is permitted providing the codebook allows for this. Bullet-point lists and tables are treated as equivalent to paragraphs.

Krippendorff defined the third unit type as context units which is the surrounding context that may be used to interpret a recording unit (Krippendorff, 2018, pp. 105–107). In this thesis the context units are the subchapters in which the paragraph appears. Reference to more distant parts of the report is made only if the paragraph explicitly points to them. In this way context is not treated as a matter of free interpretation but as a rule-based interpretative framework.

3.4. Step 2: Sampling

The subject of this thesis is the corporate reports of the 40 DAX companies. Since the study transforms report-based statements into analyzable data, only material with a sufficient degree

of formal structure is considered. Informal forms of communication such as press releases are excluded because they may differ significantly in terms of objectives, level of detail, and degree of standardization which would reduce coding comparability (Borgstedt et al., 2019, p. 182).

In order to define the material basis uniformly, the report types used are operationalized. Following prior studies (Borgstedt et al., 2019; Papafloratos et al., 2023; Posadas et al., 2023; Schwoy et al., 2025; Taşoğlu et al., 2024) a distinction is made between the following report types:

1. Sustainability Report / ESG Report

A Sustainability or ESG Report is a standalone document presenting sustainability issues or ESG content and typically contains chapters on environmental, social, and governance topics. It is characterized by a thematic structure, the presentation of key figures, and a methodological framework. In the present sample, this report type accounts for eight of the 40 reports.

2. Integrated Report

An Integrated Report combines financial and non-financial information and communicates sustainability as an integral part of corporate management and value creation. Sustainability content is typically embedded in strategy, risk, and governance sections, but may also include dedicated environmental chapters. In the present sample, this report type accounts for one of the 40 reports.

3. Annual Report

An Annual Report primarily addresses financial reporting content but includes a clearly defined section on sustainability or ESG reporting. In the present sample, this report type accounts for 31 of the 40 reports.

Since individual companies often publish several reporting documents in parallel, a priority rule is applied to define exactly one document per company as the sampling unit: primarily a sustainability report or ESG report is selected. If this is not available, an integrated report is used and if this is also unavailable an annual report with substantial ESG sections is selected (Posadas et al., 2023, p. 32). An overview of the sample and data is provided in Table 1.

N=40	Company Name	Reporting Medium (Year 2024)	NAICS Sector Name
1	Allianz SE	Annual Report	Finance and Insurance
2	Commerzbank AG	Annual Report	
3	Deutsche Bank AG	Annual Report	
4	Deutsche Boerse AG	Annual Report	
5	Hannover Rueck AG	Annual Report	
6	Muenchener Rueckversicherungs-Gesellschaft in Muenchen AG	Annual Report	
7	Fresenius Medical Care AG	Sustainability Report	Health Care and Social Assistance
8	Fresenius SE & Co KGaA	Annual Report	
9	Deutsche Telekom AG	Annual Report	Information
10	SAP SE	Integrated Report	
11	Scout24 SE	Annual Report	
12	Adidas AG	Annual Report	Manufacturing
13	Airbus SE	Annual Report	
14	BASF SE	Annual Report	
15	Bayer AG	Annual Report	
16	Bayerische Motoren Werke AG	Annual Report	
17	Beiersdorf AG	Annual Report	
18	Continental AG	Annual Report	
19	Daimler Truck Holding AG	Annual Report	
20	GEA Group AG	Annual Report	
21	Heidelberg Materials AG	Annual Report	
22	Henkel AG & Co KGaA	Sustainability Report	
23	Infineon Technologies AG	Sustainability Report	
24	Mercedes-Benz Group AG	Annual Report	
25	Merck KGaA	Annual Report	
26	MTU Aero Engines AG	Annual Report	
27	Porsche Automobil Holding SE	Sustainability Report	
28	Qiagen NV	Sustainability Report	
29	Rheinmetall AG	Annual Report	
30	Siemens AG	Sustainability Report	
31	Siemens Energy AG	Sustainability Report	
32	Siemens Healthineers AG	Sustainability Report	
33	Symrise AG	Annual Report	
34	Volkswagen AG	Annual Report	
35	Vonovia SE	Annual Report	Real Estate and Rental and Leasing
36	Zalando SE	Annual Report	Retail Trade
37	Deutsche Post	Annual Report	Transportation and Warehousing
38	E. ON SE	Annual Report	Utilities
39	RWE AG	Annual Report	
40	Brenntag SE	Annual Report	Wholesale Trade

Table 1: Sample

In addition to defining the document type, the parts of the documents to be included in the analysis are also specified in line with sampling logic (Krippendorff, 2018, pp. 115–116). In

this thesis the specification is based both on the regulatory framework and on the structure of the material itself. Following the logic of Schowy et al. who first conducted a structured review of the material to identify the relevant text sections a similar approach is adopted here (Schwoy et al., 2025, p. 675). First, the relevant literature and conceptual frameworks on reporting media and the CSRD regulatory framework were reviewed in order to determine the expected content. Second, one complete company report was read exploratorily to examine where the information central to the deductive categories is typically located. This material-based review confirmed that the most standardized and comparable reporting content can be found where information is explicitly structured along the ESRS.

Against this background, the section of the reports to be coded is limited to ESRS topics related to the environment. Specifically, only text passages that can be assigned to the five environmental standards are coded: ESRS E1 – Climate Change; ESRS E2 – Pollution; ESRS E3 – Water and Marine Resources; ESRS E4 – Biodiversity and Ecosystems; ESRS E5 – Resource Use and Circular Economy.

In practical terms this means that only paragraphs that can be clearly assigned to one of these five ESRS environmental topics are coded. Statements outside these topics are not coded even if they are relevant to sustainability in a broader sense.

3.5. Step 3: Recording/coding

3.5.1. Category system

The codebook comprises three main categories (A-C), each of which captures a distinct dimension of corporate visibility and together operationalize how ES-related information becomes observable in reporting:

- A. Reference to External Sources
- B. Ecosystem Services
- C. Information Intensity

The categories follow a cumulative analytical logic. Category B (Ecosystem Services) serves as the primary thematic entry point by identifying whether a paragraph addresses an ES-related issue within the environmental ESRS topics. Category C (Information Intensity) then captures how this issue is represented in reporting, that is, whether it is communicated qualitatively, physically, monetarily, or analytically. Finally, Category A (Reference to External Sources) assesses whether the disclosure is explicitly anchored in external reference frameworks and more specifically whether such anchoring points to NEA-related or official accounting-based

sources. Accordingly, the category system does not treat topic, form, and references as separate phenomena but as connected dimensions of the visible reporting-level treatment of ES-related information.

Category A (Reference to External Sources) captures whether and to what extent a coded paragraph is linked to national, state, or official data sources that represent ecological systems, environmental indicators, or natural capital/ecosystem accounting. The core of this category is therefore not the environmental claim itself, but rather the reference logic underlying the disclosure. More specifically, the category is used to identify whether disclosures are explicitly anchored in NEA-related references or in other official public data sources. A distinction is made between following subcategories (Schwoy et al., 2025, p. 676):

The first subcategory is “A0 – not reported”. This category is coded if no reference to NEA or any other official data source is apparent. The second subcategory is “A1 – brief statement”. It is coded when a reference is made to a source without explicitly identifying it as environmental-economic accounting or ecosystem accounting. In such cases, companies may name a public source without indicating that the statement is grounded in an environmental accounting system (Grunewald et al., 2024, p. 27). An example is: To quantify the nuclear share of electricity and heat consumption in the upstream supply chain, a country-specific proportional calculation was performed using national statistical data. The underlying data comes from the International Energy Agency (IEA) database (Fresenius SE & Co KGaA, 2024, p. 194). The third subcategory is “A2 – systematic statement”. This subcategory is assigned when the paragraph explicitly refers to a specific official or statistical source in the sense of environmental-economic accounts, ecosystem accounts, or other government environmental accounting systems, such as Eurostat environmental accounts. An illustrative example could be: To contextualize biodiversity impacts, we draw on the national ecosystem accounts complied under the UN SEEA Ecosystem Accounting framework, including ecosystem extent and condition indicators.

If several references appear within a single paragraph, a hierarchy rule applies whereby the highest degree of specificity is decisive. For example, if a passage contains both a brief statement and a systematic statement, A2 – systematic statement is assigned. If a source is mentioned only in a footnote A1 – brief statement or A2 – systematic statement may be assigned provided that source can be clearly linked to the statement made in the paragraph.

Category B (Ecosystem Services) provides the primary thematic classification of the coded material. It identifies which type of ES-related issue is made visible by assigning the relevant

ESRS environmental topic to a broader ES category. The coding follows the typology derived from CICES. Since the analysis is limited to ESRS environmental sections each of the five environmental ESRS topics is assigned to the ES type it most closely reflects from an analytical point of view. Importantly, this assignment does not imply that ESRS topics and ES are conceptual identical. Rather, it functions as an analytical translation device that structures corporate environmental disclosures according to the dominant ES logic they most closely relate to. Previous studies have used established ES typologies and have shown that key environmental functions including climate regulation, air quality regulation, and biodiversity-related functions can be consistently assigned to the category of regulating or regulation-and-maintenance services. For example, Boerema et al. explicitly classify climate and air regulation as regulating services (Boerema et al., 2017, p. 360). Grammatikopoulou & Vačkářová likewise use CICES and cite climate regulation, air quality regulation, and habitat maintenance as examples of regulating and maintenance services (Grammatikopoulou & Vačkářová, 2021, pp. 4, 9). In contrast, both studies group services linked to usable natural resources and resource provision under provisioning services. Boerema et al. for instance classify water provision and material services as provisioning services (Boerema et al., 2017, p. 360).

Following this logic ESRS topics that focus on biophysical regulatory functions and the stabilization of environmental conditions (climate, pollution, and biodiversity and ecosystems) are interpreted as regulating services, whereas topics that primarily relate to the provision and use of natural resources as inputs (water and marine resources and resource use and circular economy) are interpreted as provisioning services. Accordingly, the subcategory “B1 – provisioning services” is coded when the paragraph is located within the analysis sections on Water and Marine Resources or Resource Use and Circular Economy. The subcategory “B2 – regulating services” is assigned when the paragraph is located within the analysis sections on Climate Change, Pollution, or Biodiversity and Ecosystems. None of the five environmental ESRS topics can be meaningfully assigned to cultural services in the context of this study. Cultural services are therefore not included in the category system.

Category C (Information Intensity) captures the representational form of ES-related information identified through Category B (Ecosystem Services). It therefore indicates how the issue is made visible in reporting: whether a passage remains purely qualitative or whether it is expressed in a form that is measurable, economically valued, or analytically processed. The scale is ordinal and differentiates between four levels: qualitative, physical, monetary, and analytical (Akhter et al., 2023, p. 352).

“C0 – qualitative” is assigned when statements are exclusively verbal such as target announcements, declarations of intent, or general descriptions without figures, units, or quantifiable variables. An example is: We plan to reduce CO₂e emissions over a period of five years (BMW Group, 2024, p. 120). “C1 – physical” covers physical quantification understood as information expressed in physical units or proportions without monetary valuation. An example would be: We measure our emission reduction in 1,000 metric tons of CO₂ (Siemens AG, 2024, p. 66). The subcategory “C2 – monetary” is coded when the ES-related variable is directly expressed in monetary terms. It applies only where the ES or an environmental output/impact relevant to ES is monetized. The decisive criterion is therefore not whether monetary amounts appear somewhere in the report, but whether a monetary valuation is directly linked to the ES-relevant variable. C2 applies when a company reports an issue as a price, value, or cost rate directly connected to an ES-relevant unit (e.g., €/t CO₂, €/m³ water, €/ha habitat, or a comparable monetary valuation approach) or when monetization is explicitly reported as a result. An example is: A globally applicable internal CO₂ price of €100 per ton of CO₂e is used as a valuation assumption for the relevant CapEx investment projects (Merck KGaA, 2024, p. 167). Finally, “C3 – analytical” is assigned when information is processed analytically beyond the mere mention of numbers for example through modelling, scenario analysis, risk analysis, or other methodologically explicit forms of evaluations. An example is: The GEA Group used climate scenario analyses for multiple time horizons to assess relevant climate-related opportunities and risks and test resilience of its corporate strategy (GEA Group A, 2024, p. 91). Multiple codes may be assigned within Category C (Information Intensity) if several forms of representation are present. If a value is mentioned without sufficient specification, C0 – qualitative is generally assigned unless the monetary context is explicit.

The conceptual interrelation of the categories is central to the coding process. Category B (Ecosystem Services) functions as the primary thematic filter and therefore as necessary entry condition for further coding. Only if a paragraph can first be identified as addressing an ES-related issue within the defined ESRS environmental topics is it subsequently examined in terms of how this issue is represented (Category C – Information Intensity) and whether it is explicitly anchored in external or NEA-related references (Category A – Reference to External Sources). A similar logic can be found in Schwoy et al. who also tie coding to the presence of a clearly defined content trigger (Schwoy et al., 2025, pp. 673–674).

Table 2 summarizes the codebook with all categories and subcategories together with short descriptions while Table 3 presents the decision rules to be applied during coding.

Category	Subcategory	Description
A – Reference to External Sources		Whether ES-related disclosures are linked to national, official, or public data sources, including NEA
	A0 – Not reported	No reference to NEA or other public/official data sources
	A1 – Brief statement	Reference to a public/official source without explicitly identifying it as environmental-economic or ecosystem accounting
	A2 – Systematic statement	Reference to NEA or other official environmental accounting source
B – Ecosystem Services		Which type of ES-related issue is addressed
	B1 – Provisioning Services	Water and Marine Resources Resource Use and Circular Economy
	B2 – Regulating Services	Climate Change Pollution Biodiversity and Ecosystems
C – Information Intensity		How ES-related information is represented
	C0 – Qualitative	Statement is purely verbal or descriptive, without figures, units, or quantifiable information
	C1 – Physical	Information is quantitatively measurable and expressed in physical units (e.g., mass, volume)
	C2 – Monetary	ES-related information is expressed in monetary terms
	C3 – Analytical	ES-related information is processed analytically (e.g., through models, scenario analysis, risk analysis)

Table 2: Codebook

Category	Coding Logic	Additional rule / explanation
A	Hierarchical coding (A2 > A1 > A0)	Each segment is assigned only one A-level
B	Primary thematic classification	A paragraph must first be assigned to Category B before values can be assigned to Category A and Category C
C	Multiple codes allowed if several forms of representation are present	n/a

Table 3: Rules for coding

3.5.2. Coding Process

In this thesis, coding is implemented using the tool MAXQDA and validated through a combination of AI-supported preselection and manual review. MAXQDA is a software program for qualitative and mixed-methods data analysis that supports the organization, coding, retrieval, and export of textual research data, making it suitable for analyzing corporate reports (MAXQDA, n.d.).

Prior to the main coding, a pilot phase was carried out in which several reports were first read in the relevant ESRS sections and test coded. The aim was to check categories and definitions selectively, to identify recurring borderline cases, and develop a keyword list that would make relevant passages reliably findable (Miklosik & Evans, 2021, p. 4; Schwoy et al., 2025, p. 675). In this phase the wording of decision rules is clarified, and the codebook finalized. The rules are then applied unchanged to the rest of the sample to ensure consistency.

For the implementation a project is created in MAXQDA, and the 40 PDFs of the documents are imported. The documents are organized by company and report type, while the code system reflects the analytical categories of the study, including ESRS topics, representational form, and NEA-related references. Relevant metadata, the company name, the report medium, and the sector classification from LSEG is documented in a separate Excel file which would later be used for Step 4: Reducing the data. The coding is performed at the paragraph level. For each coded paragraph the page number and context are also documented to ensure coding decisions are traceable and in case of doubt auditable.

MAXQDA AI Assist is used as a support tool to preselect potentially relevant text passages. Its use follows a clear logic: AI Assist marks candidate passages based on rules/definitions linked to each of the subcategories. However, since the AI Assist is still in its development stage the final coding is only done after manually checking the marked passages. This thesis thus follows a conservative quality logic where AI outputs are treated as suggestions. In practice, all automatically suggested codes are therefore checked, corrected, or rejected if they did not comply with the decision rules. Since AI-based tagging systems could carry a risk of false negatives where relevant passages are not recognized, especially in the case of unusual wording, a full-text search is also carried out in MAXQDA. This is based on the keyword list developed in the pilot phase which covers synonyms and typical report language. Matched results are checked in context and coded if they comply with the rules. In the end, all the coding is exported to an Excel file for further use and evaluation. Repetitions of the same content within a report

are documented only once provided they are identical in content. For borderline cases short memos are recorded in the accompanying Excel file.

The coding process is summarized in Figure 3.

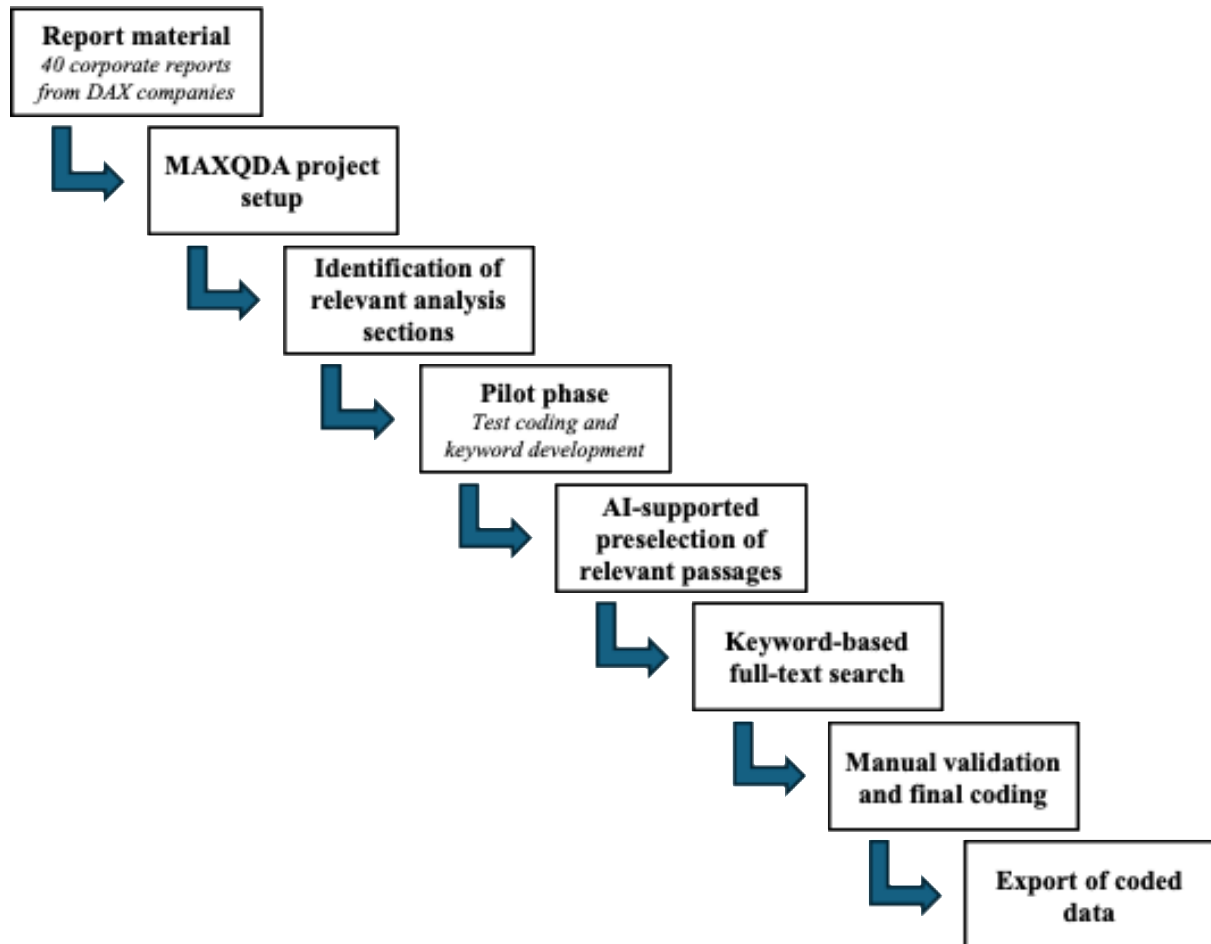


Figure 3: Coding process

3.5.3. Reliability Check

To verify inter-coder reliability a reliability check is performed using double coding. Since this thesis' evaluation is based on whether a defined subcategory appears in a company's report rather than on the number of individually coded text passages the coding is operationalized as a binary presence variable (Krippendorff, 2018, pp. 223–227). For each company the presence or absence of each subcategory is recorded. Presence is indicated by a value of 1 or “x” and absence by the value of 0. The frequency of mentions within a report is not considered as the analytical focus is on category coverage and not reporting intensity.

The reliability check covers 10% of the sample (four companies) which are coded once by MAXQDA AI Assist and once by the author using the same version of the codebook. The unit of analysis is the combination of company and ESRS category. Each coding decision is modeled as an independent nominal-scale assignment (0/1) to enable consistent reliability testing across all evaluated cells. A total of seven subcategories (A0-A2) and (C0-C3) are examined for each company, yielding a set of 28 binary coding decisions (four companies x seven subcategories) for the reliability check. Each decision is made by both coders.

To quantify inter-coder reliability, Krippendorff's alpha is calculated for the nominally scaled data (Krippendorff, 2018, pp. 223–227). This measure is suitable for categorical coding and evaluates the observed agreement between coders compared to the amount of agreement that would be expected by chance given the distribution of the categories. In this thesis, agreement is defined as identical binary decisions (1/1 or 0/0) by both coders for a company-subcategory while deviations are recorded as (1/0 or 0/1). The calculation is based on observed disagreement, or the proportion of coding decisions that differed, and expected disagreement which is derived from the overall distributions of 0s and 1s, assigned by both coders. There are no missing values in the reliability subsamples. The calculated Krippendorff's alpha is $\alpha = 0.83$. In content analysis, this value is interpreted as indicating good to very good reliability ($\alpha \geq 0.80$ is considered as the threshold for reliable evaluations) (Krippendorff, 2018, p. 241). Thus, the coding can be assessed as sufficiently consistent for subsequent analysis.

3.6. Step 4: Reducing

In Krippendorff's terms, reducing refers to the methodological step in which the raw information generated during coding is condensed and structured in a way that makes it suitable for subsequent quantitative evaluation (Krippendorff, 2018, p. 89). Whereas the recording/coding step still links codes closely to individual text passages and their context, the purpose of reducing is to transform these text-to-code assignments into a consistent data structure in which each observation unit is clearly defined, and variables are available in standardized form. In this thesis, the reduction step takes the form of an Excel-based code matrix that converts the coding results by company and by ESRS topic into a uniform analytical scheme.

The codes generated in MAXQDA are first exported from the project and transferred into a tabular data structure. The exports of coded segments, including document assignment, code assignment and segment metadata such as page numbers, serve as the starting point for the

reducing process. These exports are not used directly as the final data matrix but form the basis of a multi-stage consolidation process. More specifically, a separate Excel file is created for each company and for each ESRS topic actually covered in the respective report. These topic-specific files constitute the first stage of reduction. Within each file, the codes identified in the relevant ESRS section are merged and transformed into a compact table format. The subcategories are documented in such a way that one aggregated characteristic is recorded for each ESRS topic. The aggregation follows the coding rules defined in the codebook. In these topic-specific files, the result is presented as traceable evidence of presence, marked by an “x”.

In addition to these topic-specific consolidation files, a second and higher-level reduction stage is created in the form of a central overview matrix. In this overview sheet, companies are listed as rows, while report type and industry classification are added as descriptive columns.

Based on the ESRS topic marked in the overview sheet, the corresponding B-coding is assigned according to a uniform rule that is identical in all cases and does not depend on company-specific wording or structural variations. This assignment is also documented in the code matrix as presence information (“x”), making it transparent which ES types are considered covered in each case on the basis of the reported ESRS topics.

In a further step, the aggregated values for Categories A – Reference to External Sources and C – Information Intensity from the topic-specific Excel files are transferred into the central overview matrix. In practical terms, this means that after the first reduction stage, consolidated values for A (A0 – not reported, A1 – brief statement, A2 – systematic statement) and C (C0 – qualitative, C1 – physical, C2 – monetary, C3 – analytical) are already available for each company and for each relevant ESRS topic. These values are then merged into the overview table in a way that makes it clear whether and which characteristics appear in the report as a whole. The overview table therefore contains separate columns for A0 – not reported, A1 – brief statement, A2 – systematic statement and C0 – qualitative, C1 – physical, C2 – monetary, C3 – analytical, documenting the characteristics ultimately assigned in each case.

The result of the reducing step is a multi-layered but internally consistent data product, consisting of topic-specific summary files for each company as a traceable intermediate level and a central company-based code matrix as the final evaluation data set. On this basis, patterns and differences can be assessed in the subsequent inference step without comparability being impaired by inconsistent aggregation logics.

The entire reducing process is illustrated in Figure 4.

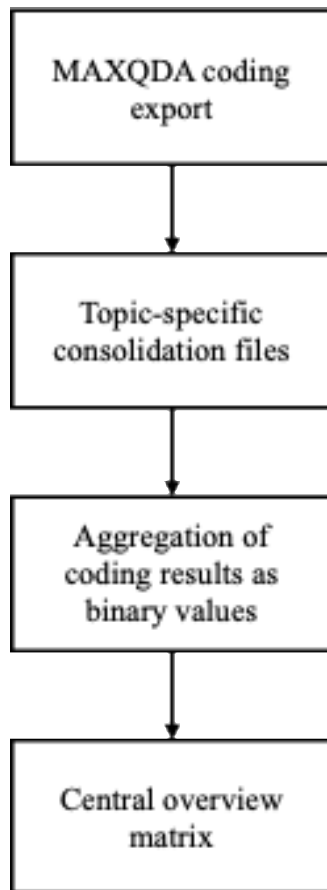


Figure 4: Reducing Process

4. Findings

The results of the H1: *In corporate sustainability reporting ecosystem service-related information is disclosed selectively with climate change being addressed more frequently than other ecosystem service-related topics* examination are based on a sample of 40 company reports and a binary operationalization. For each subcategory it is recorded whether it appears at least once in a report (present) or did not appear (absent). Therefore, the following findings presented in Table 4 should be interpreted as the proportion of companies that address a topic not the intensity or scope of reporting.

B1 – Provisioning Services		B2 – Regulating Services		
30 (75%)		40 (100%)		
Water and Marine Resources	Resource Use and Circular Economy	Climate Change	Pollution	Biodiversity and Ecosystems
20 (50%)	29 (73%)	40 (100%)	19 (48%)	18 (45%)

Table 4: Results H1

At the aggregated level, regulatory services (B2) are clearly dominant. All 40 companies (100%) mention this category. This indicates that regulatory issues are thoroughly covered in the sample and represent the most consistent reporting focus. The subcategory climate change is particularly noteworthy as it is addressed by all 40 companies and is thus not only the most frequently reported category within regulating services but also the only category in the entire sample that appears in all reports. In comparison, the other two subcategories are significantly less common. Pollution is mentioned by 19 companies (48%), just under half of the sample. Biodiversity and Ecosystems is addressed by 18 companies (45%), a level similar to pollution but slightly below. Thus, the distribution within regulating services indicates a strong thematic concentration in the area of climate change while pollution and biodiversity and ecosystems are present but addressed by only some of the companies.

In contrast, coverage of the provisioning services (B1) is lower overall. 30 of the 40 companies (75%) mention B1, meaning a quarter of the companies do not reference provisioning services at all. Within B1, there is clear differentiation between subcategories. 20 companies (50%) address water and marine resources whereas resource use and circular economy is significantly more strongly represented, mentioned by 29 companies (73%). This category not only exceeds water and marine resources significantly but also approaches the total value of B1.

For H1, a direct comparison between climate change and the other categories is important. Climate change has the highest possible frequency, far ahead of pollution and biodiversity and ecosystems within the regulating services. It is also significantly more prevalent than the provisioning categories, resource use and circular economy and water and marine resources. This reveals a clear pattern across all considered categories: climate issues are the most widely addressed topic in German corporate reporting. Therefore, H1 is supported and can be confirmed.

For contextualization purposes the frequency of occurrence is broken down by industry (Table A2 in the Appendix). The overall finding that climate change is dominant remains robust. 100% of companies in each industry address climate change (e.g., 23/23 in manufacturing and 6/6 in finance and insurance). However, differences can be seen in the less common categories. Manufacturing (n=23) has the broadest thematic coverage and drives higher values in provisioning services (22/23 = 96%), resource use and circular economy (21/23 = 91%), pollution (15/23 = 65%), water and marine resources (15/23 = 65%), and biodiversity and ecosystems (14/23 = 61%). Finance and insurance (n=6) on the other hand shows a significantly lower presence of provisioning topics (1/6 = 17%) and reports pollution, water and marine resources, and resource use and circular economy in only one out of six cases (17%). Biodiversity and ecosystems is comparatively higher at three out of six (50%) but remains well below climate change. In industries with a small number of cases (n=1–3, e.g., transportation, real estate, retail trade, and wholesale trade), the percentages should be interpreted with caution because individual reports strongly influence the percentages reported. This breakdown therefore serves primarily as a descriptive classification and not as an independent hypothesis test.

Overall, the industry breakdown highlights two main points: climate change is consistently present across all industries and the differences between industries mainly concern provisioning services with manufacturing showing the widest coverage.

The results of H2: *Ecosystem service-related information is represented more frequently in qualitative form than in physical, monetary, and analytical form* examine how companies present topics related to ES in their reports (Table 5). Four types of representation are distinguished: C0 – qualitative, C1 – physical, C2 – monetary, and C3 – analytical. These subcategories are not mutually exclusive which means that a report can present a topic qualitatively and physically or analytically. The percentages refer to the topic-specific

subsample in each case: climate change (n=40), pollution (n=19), water and marine resources (n=20), biodiversity and ecosystems (n=18), and resource use and circular economy (n=29).

C – Information Intensity	Climate Change (n=40)	Pollution (n=19)	Water and Marine Resources (n=20)	Biodiversity and Ecosystems (n=18)	Resource Use and Circular Economy (n=29)
C0 – qualitative	40 (100%)	19 (100%)	20 (100%)	18 (100%)	29 (100%)
C1 – physical	40 (100%)	12 (63%)	20 (100%)	9 (50%)	28 (97%)
C2 – monetary	13 (33%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
C3 – analytical	33 (83%)	12 (63%)	19 (95%)	16 (89%)	11 (38%)

Table 5: Results H2

Initially, it is apparent that qualitative representations (C0) dominate across all subject areas as it accounts for 100% of every subject area. Thus, qualitative narratives form the fundamental basis of reporting in all subject areas. Examples include general description of relevance, goals, or measures that do not require quantification. For instance, the company Muenchener Rueckversicherungs-Gesellschaft in Muenchen AG state the following in the context of climate change: “As part of our short-term decarbonization targets under the Munich Re Group Ambition 2025, we have committed to reducing the GHG emissions related to our primary insurance and reinsurance products. Additionally, we are striving to reduce GHG emissions from our insurance business to net zero by 2025.” (Munich Re, 2024, p. 91). Another example of a purely narrative framing is provided by Mercedes-Benz Group AG in the subject of pollution: “Environmental protection along the value chain: The Mercedes-Benz Group aims to reduce or completely avoid pollutant emissions along the entire value chain, decrease the release of microplastics into the environment, and to ensure a responsible handling of hazardous substances.” (Mercedes-Benz Group, 2024, p. 160).

In addition to C0, physical quantification (C1) is observed in several topic areas though its prevalence varies significantly depending on the topic. For climate change, C1 occurs in all 40 cases (100%) meaning every company addressing climate change uses physical units or quantified variables at least once. For water and marine resources, C1 is also present in all cases whereas for resource use and circular economy it is present in 97% cases. In contrast, C1 is present in only 12 out of 19 cases (63%) for pollution and in 9 out of 18 cases (50%) for biodiversity and ecosystems. Physical representations are often provided using key figures on

emissions, consumption, or material weight. Accordingly, Commerzbank AG describes climate change, for example, as: “At Commerzbank AG’s international locations, the power supply has been switched to green electricity. This initiative led to a reduction of indirect emission in Scope 2 by approximately 3,900 t CO₂eq.” (Commerzbank AG, 2024, p. 97). Another example of the use of physical units is provided by Heidelberg Materials AG in the subject of resource use and circular economy: “The total weight of recycled aggregates produced for the 2024 financial year was 4.7 million tonnes, corresponding to a share of 1.7%.” (Heidelberg Materials AG, 2024, p. 158).

Monetary representations (C2) demonstrate significantly greater selectivity. Monetization exclusively occurs in the climate topic. For climate change, C2 accounts for 33% of cases, whereas it accounts for 0% for pollution, water and marine resources, biodiversity and ecosystems, and resource use and circular economy. Symrise AG demonstrates monetary integration by stating: “Another tool Symrise has developed to promote internal emissions reduction is the Symrise Carbon Control Price (SCCP), which will go into effect in 2025. This internal carbon price is based on international standards and scientific recommendations, including the Carbon Disclosure Project (CDP) and the UN Global Compact. In addition, Symrise is guided by the recommendations of the Science Based Targets initiative (SBTi) and the High-Level Commission on Carbon Prices, which also recommends a corresponding price range. The SCCP is a shadow price for CO₂eq that requires no real cash transfers but integrates CO₂eq costs into investment and operational decisions. It will start at € 60 per metric ton of CO₂eq in 2025 and rise to € 140 by 2035, with a review scheduled for 2027 to determine the further price development. The SCCP applies to Scope 1 and Scope 2 emissions as well as energy-related emissions in Scope 3 (upstream), affecting in particular investments in capital expenditure and energy procurement. By applying the SCCP to all of its global sites, the company ensures that a uniform price is applied for CO₂eq worldwide.” (Symrise AG, 2024, pp. 122–123). Similarly, other companies like Henkel AG & Co KGaA report on monetization in climate change as follows: “A global average CO₂ price was calculated for the shadow price model based on the weighted average of the national and regional CO₂ price, in which the latest data from the World Bank was used. To calculate the weighting factors, Henkel’s GHG emissions in the respective countries were used. The global average calculated for the reporting year 2024 amounted to USD 19.1 per CO₂ metric ton.” (Henkel AG & Co KGaA, 2024, p. 170). Finally, the analytical presentation (C3) is recorded. This category includes scenario analyses, risk-related modeling, and systematic risk arguments, and is mostly linked to risk/impact logic. Overall, a high level of performance was evident in several subject areas though there were

significant differences. For climate change, C3 accounted for 33 out of 40 cases (83%). For pollution it is 63%, for water and marine resources it is 95% and for biodiversity and ecosystems 89%. However, there is a striking contrast in resource use and circular economy where C3 only reached 11 out of 29 cases (38%) and was thus significantly less frequent than in the other topics. Analytical representations appear when companies explicitly address risk, dependencies, transition paths, or scenario assumptions. For instance, Bayer AG explains a risk related analysis in the context of water and marine resources as follows: “Our water consumption in regions impacted by water risks according to ESRS, including regions with high water stress according to ESRS, was 5.6 million m³ in 2024 (2023: 4.92 million m³). We identify these regions using the data from the Aqueduct Water Risk Atlas 4.0 of the World Resources Institute (WRI). The evaluation covers all sites impacted by water risks (Weighted Aggregated Water Risk Total by Default Weighing Scheme indicator is ≥ 3) and all sites in regions with a high level of water stress (Baseline Water Stress indicator is ≥ 0.4).” (Bayer AG, 2024, p. 167). Another example illustrating a scenario or risk argument is provided by Adidas AG in the area of climate change: “For our climate scenario/risk analysis, we used a climate modeling tool with the ability to model different climate scenarios; we used three climate scenarios covering a low, intermediate and high emissions scenario. On this basis, we assessed our exposure in each scenario and the related vulnerability to selected climate hazards – wind, flood, avalanche, landslide, temperature, wildfire, snowfall, earthquake, and soil liquefaction – using more specific climate indicators, e.g., wind gust speed, blizzards, or average wind speed. The tool allowed us to create a digital twin of our business model (focusing on operational footprint, key own assets, main sourced materials, strategic suppliers, and supply chain information, including certain distribution routes) to provide focused information on our vulnerability. As a result, an in-depth view of our exposure to physical risks at the asset level formed the basis for identifying and assessing the material climate-related physical risks in the three different time frames assessed (2030, 2040, 2050).” (Adidas AG, 2024, p. 167).

Taken together, the table demonstrates two things. First, qualitative reporting (C0) is universal across all subject areas (consistently 100%). Second, depending on the topic, the narrative basis is supported by physical indicators (C1) and analytical risk/scenario elements (C3) to varying degrees. Monetization (C2) is practically absent, occurring exclusively in the climate context.

The results support H2. While all subject areas have consistent qualitative framing, the results show that physical and analytical representations appear as supplements depending on the topic. Monetary representation is rare, appearing exclusively in the climate context and is not observed in any other subject area.

In addition to the overall results, the industry breakdown in Table A3 in the Appendix shows that qualitative representations occur consistently across all industries and topics. In several industries this qualitative basis is often supplemented by physical data. For example, in manufacturing, physical disclosures are particularly high for climate change (100%), water and marine resources (100%), and resource use and circular economy (95%). However, they are lower for pollution (67%) and biodiversity and ecosystems (50%). In finance and insurance, climate change, water and marine resources, and resource use and circular economy are reported physically (100% for each) while physical representations are significantly less common for pollution (0%) and biodiversity and ecosystems (33%). In smaller industries, C1 – physical is often complete. An exception is retail trade where climate change, water and marine resources, and resource use and circular economy is addressed physically (100% each) while pollution is not (0%).

However, the industries differ greatly when it comes to analytical representations (C3). In manufacturing, analyses are common for water and marine resources (93%), biodiversity and ecosystems (86%), and climate change (78%) but uncommon for resource use and circular economy (38%) and pollution (67%). In finance and insurance, analytical representations are consistently available for all topics. In smaller industries, analyses are sometimes complete while they are more often missing in resource use and circular economy.

Overall, monetary representations (C2) remain an exception and are essentially limited to individual industries. In manufacturing monetization occurs only for climate change (52%) while it is 0% for the other covered topics. In most other industries, C2 is consistently 0%. One notable exception is wholesale trade where climate change is monetarily reported (100%) while pollution, water and marine resources, and resource use and circular economy are not monetarily reported.

The results for H3: *Corporate sustainability reports rarely include explicit references to NEA as a source framework for ecosystem service-related disclosures* distinguish three levels of the integration of national ecosystem service data for each topic area: A0 – not reported; A1 – brief statements, and A2 – systematic statement (Table 6). As with the previous hypothesis, the percentages refer to the topic-specific subsample: climate change (n=40), pollution (n=19), water and marine resources (n=20), biodiversity and ecosystems (n=18), and resource use and circular economy (n=29).

A – Reference to National Ecosystem Service Data	Climate Change (n=40)	Pollution (n=19)	Water and Marine Resources (n=20)	Biodiversity and Ecosystems (n=18)	Resource Use and Circular Economy (n=29)
A0 – not reported	9 (23%)	18 (95%)	19 (95%)	16 (89%)	24 (83%)
A1 – brief statement	31 (78%)	1 (5%)	1 (5%)	2 (11%)	5 (17%)
A2 – systematic statement	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Table 6: Results H3

A consistent pattern emerges across all topics: reporting is predominantly in the form of a brief statement, completely absent, or entirely lacking a systematic statement. For climate change, nine companies (23%) fall under A0, 31 companies (78%) under A1 and none under A2. Brief statement clearly dominates. Several reports illustrate the typical A1 expression in the climate context with brief statements that address climate issues using official statistics and databases. However, these reports do not specifically mention environmental accounting or link the databases to it. Overall, reporting is significantly less elaborate for pollution. 18 companies (95%) are coded as not reported and only one company (5%) contains a brief statement. No companies are coded as A2. The situation is similar to water and marine resources. 19 companies (95%) are coded as not reported, one company (5%) is coded as a brief statement and there are no systematic mentions. For biodiversity and ecosystems there is also strong dominance of A0. 16 companies (89%) do not report on national ecosystem data while two companies (11%) include a brief statement. A2 does not appear here either. For the resource use and circular economy category the distribution is somewhat similar to the previous mentioned topics. 24 companies (83%) do not report on nation ecosystem data, five companies (17%) make a brief statement, and no companies include a systematic statement.

Beiersdorf AG, for example, describes A1 as follows: “Based on an economic and environmental input-output (EEIO) model, Beiersdorf began by identifying the most relevant categories of Scope 3 emissions using expenditures data. The EEIO model evaluates resource consumption and environmental impact throughout the supply chain on the basis of international statistics and databases.” (Beiersdorf, 2024, p. 71).

In summary, reporting on national ecosystem service data in the sample is predominantly not existent or brief. In all topic areas, A2 does not appear at all. The high A0 percentages (95%, 95%, 89%, and 83%) indicate frequent non-consideration of environmental accounting.

These findings confirm hypothesis H3. When addressing topics relevant to ecosystem services, companies predominantly provide brief statements (A1) about national ecosystem service data, while systematic statements (A2) are not existing.

In addition to the overall results of the integration of NEA data, reporting was also evaluated by industry (Table A4 in the Appendix). The breakdown confirms the overall pattern that environmental accounting predominantly appears in the form of brief statements (A1) and systematic statements (A2) are missing. This is most evident in the manufacturing sector. For climate change, brief statements dominate (70%) with seven cases of non-reporting (30%). In the other topic areas, however, non-reporting clearly predominates in manufacturing. In pollution there are no mentions of environmental accounting in 14 cases (93%) with only one brief statement (7%). Water and marine resources and biodiversity and ecosystem do not reference NEA data at all. Resource use and circular economy also largely make no references (90%) with a few brief (10%), and no systematic statements. Thus, the few systematic representations in this industry occur exclusively in the context of climate change.

In finance and insurance environmental accounting in climate change consistently appears as brief statements (100%). Meanwhile, pollution and water and marine resources have no mentions (both A0: 100%), biodiversity and ecosystems are mixed with 67% no mentions and 33% brief statements, and in resource use and circular economy brief statements (100%) are present. In smaller industries ($n = 1-3$) the values are primarily descriptive but reflect the same pattern.

Summarized, a systematic statement is practically non-existent, and brief statements are dominant in every industry, except for wholesale trade where no references were made.

5. Discussion and conclusion

5.1. Discussion

Building on prior research showing that climate-, emissions-, and energy-related issues are particularly visible in corporate environmental and sustainability reporting, this thesis examines whether a similar pattern of visibility emerges when corporate reports are analyzed through the lens of ES. The analysis focuses on ES-related information within the following ESRS environmental topics: climate change, pollution, water and marine resources, biodiversity and ecosystems, and resource use and circular economy. Specifically, it examines

three dimensions of corporate visibility: which ES-related topics are covered, how these topics are represented, and whether disclosures are explicitly anchored in external or NEA-related reference frameworks. To this end, the thesis analyzes 40 corporate reports published by DAX companies for the 2024 reporting year.

The first key finding is that ES-related reporting is highly selective. This means that companies do not make all ES-related environmental topics equally visible, even though all ESRS environmental topics can be conceptually linked to ES. Instead, reporting focuses on areas for which metrics, reporting routines, and external expectations already exist. Climate change-related information, for example, is broadly visible through disclosures on greenhouse gas emissions, energy use, decarbonization targets, transition plans, and climate-related risks. In contrast, pollution, water and marine resources, biodiversity and ecosystems, and resource use and circular economy are reported on by only some of the sample. This means that visibility across ESRS environmental topics is uneven rather than balanced. In substantive terms the results support H1: ES-related information is not disclosed evenly across topics but concentrates most strongly on climate change. This finding is consistent with prior literature showing that emission- and energy-related content tends to dominate environmental and sustainability reporting (Borgstedt et al., 2019; Cubilla - Montilla et al., 2020; Papafloratos et al., 2023). The present results therefore do not suggest an isolated pattern in the DAX sample but fit a broader reporting trajectory in which climate-related information has become the most visible and standardized environmental disclosure field.

From a theoretical perspective, this concentration can be explained most convincingly through stakeholder theory, legitimacy theory, and institutional theory. Stakeholder theory suggests that firms prioritize those issues for which information demands are particularly salient, visible, and comparable. Climate change is especially suitable for this because stakeholders can observe performance through established metrics, targets, and progress indicators. Legitimacy theory complements this interpretation: because climate change is highly politicized and publicly scrutinized firms have strong incentives to communicate extensively in this area in order to maintain social acceptance and signal responsible conduct. Institutional theory further explains why this pattern becomes stable across companies. Climate reporting is supported by mature metrics, professional routines, and widely accepted disclosure templates which reduce interpretive uncertainty and make reporting easier to standardize.

For the research question this means that corporate visibility of ES-related information is shaped less by ecological relevance alone than by the existence of established reporting

conventions. In other words, what becomes visible in reporting is not simply what is environmentally important, but what can be translated into recognizable, comparable, and institutionally supported disclosure formats.

This interpretation is also relevant for the distinction between provisioning and regulating services. Assuming that climate change, pollution, and biodiversity and ecosystems primarily relate to regulating services whereas water and marine resources and resource use and circular economy primarily relate to provisioning services, the findings indicate that regulating service-related topics are more visible overall. However, this visibility is heavily concentrated in climate reporting. A likely reason is that the ESRS structure itself reinforces this asymmetry as climate change already benefits from a highly institutionalized disclosure infrastructure whereas other nature-related topics often require more site-specific, context-dependent, and methodologically contested forms of evidence. The observed imbalance therefore reflects a gap between standardized, cross-company reporting categories and the more specific ecosystem dependencies and impacts that occur at site, value-chain, or ecosystem level. Accordingly, the results point not only to thematic selectivity, but also to a broader selectivity in what can be stabilized as reportable evidence within corporate reporting.

Main finding 1: Climate change- related ES information dominates ES-related reporting under the ESRS. This suggests that corporate visibility is strongest where external expectations and established reporting conventions enable a standardized and comparable form of disclosure.

The second key finding concerns the representational form of reporting. The results show that qualitative disclosure constitutes the universal baseline across all ESRS environmental topics examined. At the same time, physical indicators and analytical elements are not absent. Rather, they appear as selective additions depending on the topic and the available reporting infrastructure. H2 is therefore supported as qualitative representation clearly predominant, and physical and analytical forms are recurring complements rather than marginal exceptions.

This pattern is consistent with prior research. Previous studies describe ES-related and natural capital-related reporting as predominantly descriptive and only selectively quantified (D’Amato et al., 2024; Grunewald et al., 2024). Research on disclosure formats similarly shows that narrative reporting remains central while quantitative and especially monetary disclosures do not dominate consistently across reports (Akhter et al., 2023). The findings of this thesis therefore align with the broader literature rather than diverging from it. At the same time, the present results refine this literature by showing that qualitative disclosure does not stand alone.

Instead, it often functions as a baseline layer to which more formalized physical or analytical elements are selectively added.

The result can be explained by combining information processing theory, decision usefulness theory, absorptive capacity, and commensuration. From an information processing perspective, ES-related reporting often involves substantial complexity because it requires data collection, contextualization, and interpretation. Narrative disclosure reduces this complexity and allows firms to communicate relevance and action even where data are heterogeneous or uncertain. Decision usefulness theory complements this view. Firms are likely to favor reporting formats that remain understandable and communicatively efficient for intended audiences. Absorptive capacity explains why physical and analytical extensions occur unevenly across topics. Even where data exists, firms need the organizational capability to acquire, assimilate, transform, and exploit information in reportable form. Finally, the rarity of monetary valuation can be interpreted through commensuration. Monetization requires stable valuation conventions, accepted proxies, and institutional legitimacy. These conditions appear relatively established in climate-related contexts, for example in internal carbon pricing, but remain far weaker for other ES-related issues.

For the research question, this means that ES-related information becomes visible in reporting primarily through a layered representation logic. Firms first establish relevance narratively and then add physical, analytical, or more rarely monetary elements where data routines, organizational capabilities, and accepted conventions allow further formalization. This layering logic is important because it shows that visibility in reporting is not a binary matter of presence versus absence. Rather, ES-relevant information becomes visible to different degrees depending on how far it can be translated into increasingly formalized and communicatively manageable disclosure formats.

Analytical forms deserve particular attention. Unlike monetization they do not require a shared monetary unit but can operate through models, scenarios, or risk analyses. This helps explain why analytical disclosure is more widespread than monetary valuation. Yet analytical representation is still uneven across topics suggesting that formalization remains constrained by methodological capacity and data availability. This again supports the argument that the central barrier is not simply the absence of environmental information, but the difficulty of translating such information into forms that are sufficiently robust, comparable, and decision-useful within firm-level reporting.

Main finding 2: Qualitative disclosure is the predominant baseline across topics, while physical and analytical elements function as topic-dependent extensions. Monetary valuation remains exceptional and is concentrated in contexts where commensuration is institutionally legitimized and considered decision relevant.

The third key finding is that corporate reports rarely make external sources explicit in a systematic and verifiable manner and almost never anchor ES-related disclosures in NEA or comparable official accounting frameworks. In Category A (reference to external sources) the dominant pattern is either the absence of any source reference or the use of only brief source mentions. Systematic statements are absent across all environmental ESRS topics. Even where brief references occur, especially in the climate change context, they usually refer to official statistics or databases without explicitly linking them to environmental-economic or ecosystem accounting.

The finding is consistent with prior literature indicating that macro-level natural capital accounting and firm-level reporting have not yet become tightly integrated. D'Amato et al. (2024) argue that even where macro-micro coherence in natural capital accounting is conceptually possible it is not commonly interpreted or applied in a strictly compatible way. The present results support that view by showing that NEA does not currently function as a routine explicit reference infrastructure in corporate reporting. This is a particularly important result because it sharpens the distinction between ES-relevant reporting on the one hand and explicit NEA anchoring on the other. The findings show that these are not the same. Firms may report on issues that are clearly ES-relevant without making NEA visible as an explicit accounting frame.

The most convincing theoretical explanations here are information processing theory, absorptive capacity, decision usefulness, institutional theory, and commensuration. From an information processing perspective, NEA provides a standardized logic, but its aggregate structure often does not match company-specific reporting needs. Absorptive capacity sharpens this explanation because to use NEA explicitly firms would have to identify relevant accounts, interpret their concepts, transform them into internal reporting categories, and embed them into indicators, analyses, or target systems. The low visibility of systematic NEA references suggest that this translation chain often remains incomplete. Decision usefulness theory adds that firms will not necessarily adopt highly demanding reference structures if the communicative and methodological costs outweigh the perceived reporting benefit. Institutional theory explains

why this remains a broader pattern. NEA is anchored primarily in official statistics and environmental-economic accounting, not yet in a strongly institutionalized corporate disclosure arena. Commensuration further clarifies why explicit anchoring can be unattractive because it may expose firms to questions about boundaries, assumptions, valuation logic, and uncertainty in areas where conventions are still unstable.

For the research question this means that the corporate visibility of NEA remains low not primarily because ecosystem accounting data do not exist but because they are difficult to translate into reporting formats that are company-relevant, decision-useful, and communicatively manageable. In other words, the findings do not merely indicate limited uptake. They point to a structural mismatch between the standardized logic of NEA and the selective logic of corporate sustainability reporting.

At the same time the result must be interpreted carefully. The absence of systematic NEA references in public reporting does not prove that companies do not use such information internally. It does show however, that within the analyzed ESRS sections NEA is currently not made explicitly visible as a transparent and verifiable reference framework.

Main finding 3: Explicit anchoring in NEA-related references is largely absent from corporate reporting. This suggests that NEA has not yet become a routine reference infrastructure in ESRS-related disclosure practice.

The fourth key finding is that industries share the same general climate-centric reporting core but differ in how broadly they cover other ESRS environmental topics and in the representational forms they use beyond climate change. Climate change is present across all industries. Sectoral variation is therefore less visible in whether climate change is reported and more visible in the breadth of reporting on other topics, in the balance between physical and analytical forms, and in the use of external sources as credibility signals.

The finding is broadly in line with prior literature. Previous studies show that climate- and emission-related issues tend to dominate disclosure hierarchies across sectors while other environmental topics receive more uneven attention. (Borgstedt et al., 2019; Papafloratos et al., 2023; Taşoğlu et al., 2024). The industry breakdown in this thesis therefore does not contradict the general climate-centered pattern identified in the literature but specifies how different industries operationalize it.

The theoretical explanation lies mainly in stakeholder theory, information processing theory, absorptive capacity, decision usefulness, and institutional theory. Across industries, nature-related dependencies and impacts are translated into different reporting grammars depending on their business model, data environment, and institutionalized forms of evidence. In some sectors, environmental relevance is more readily expressed through material flows, water use, emissions, or waste indicators, which makes physical representations more feasible. In others, environmental issues are more likely to be translated into analytical and risk-oriented forms, for example through scenario analysis or exposure assessment. Institutional theory helps explain why these sectoral grammars persist despite ESRS harmonization. Industries differ not only in what they disclose but also in which forms of evidence and quantification are considered legitimate and meaningful. This implies that corporate visibility is not only topic-selective but also mediated by sector-specific reporting logics that shape how environmental information becomes reportable in the first place.

For the research question this means that ES-related information does become visible across sectors, but it is filtered through different industry-specific reporting grammars. Corporate visibility is therefore not only topic-selective but also sectorally mediated.

A consistent cross-industry result is that NEA does not emerge as an explicit reference infrastructure in any sector. External sources are used mainly as brief and non-committal credibility signals especially in climate change reporting rather than as transparent accounting-based anchors.

Main finding 4: Although industries share a common focus on climate change, they differ substantially in how broadly they report on other environmental topics and in the dominant representation logic they use. Physical and efficiency-oriented forms are more visible in some sectors while analytical forms dominate in others. Explicit NEA anchoring remains weak across all industries.

Taken together the findings show that ES-related information becomes visible in corporate sustainability reporting in a structured but uneven manner. Climate change functions as the dominant entry point while other environmental topics appear less consistently and with greater variation in representational form. Qualitative narrative serves as the universal baseline whereas physical indicators and analytical elements are added selectively where data routines, organizational capabilities, and reporting conventions support formalization. Monetary valuation remains rare and is largely confined to contexts in which commensuration is

institutionally legitimized such as in carbon pricing logics. Finally, explicit source anchoring remains limited and does not take the form of systematic, verifiable references to NEA. Overall, the discussion suggests that the key issue is not simply whether ecosystem accounting-related information exists but whether it can be translated into disclosure formats that are compatible with firm-level reporting logics. In this sense, the thesis indicates that the current boundary between NEA and corporate sustainability reporting is shaped less by data absence than by selective visibility, uneven formalization, and persistent translation barriers. More broadly, this thesis suggests that current corporate sustainability reporting does not mirror the full ecological complexity of ES but selectively renders visible those aspects that can be aligned with established expectations, reporting routines, and communicatively effective forms of evidence.

5.2. Implications for theory and practice

5.2.1. Theoretical implications

The results of this thesis have several theoretical implications for the literature on sustainability reporting, ES, and the integration gap between NEA and corporate sustainability reporting. First, the findings suggest that the visibility and reportability of environmental information are driven less by ecological relevance alone than by issue salience and translation feasibility, which can be interpreted through stakeholder and legitimacy-based perspectives. While the ESRS framework generally prompts firms to address ES-related content, reporting remains strongly centered on climate change as a dominant and highly institutionalized topic, whereas other environmental issues are covered more selectively and inconsistently. This pattern indicates that corporate reporting tends to privilege topics that can be translated into established disclosure conventions, that is, topics for which regulatory expectations, stakeholder attention, data availability, and measurement conventions coincide.

Second, the results refine institutional theory expectations regarding standardization under the ESRS. The analysis reveals a convergent basic reporting structure but not an automatic development toward comprehensive environmental reporting grounded in external accounting infrastructure. The observed selectivity implies that the institutionalization of nature-related topics beyond climate change remains incomplete because stable indicator, benchmark, and validation practices are often weaker or less deeply embedded. Standard setting may therefore create minimum reporting structures, but the actual quality and depth of disclosures still depend on the maturity of the underlying measurement and comparability infrastructure. This extends existing work on institutionalization by suggesting that harmonized standards do not eliminate

variation in reporting quality. Rather, they interact with unequal levels of methodological maturity across environmental topics.

Third, this thesis contributes to information processing and decision usefulness perspective by identifying a layered representation logic of ES-related information. Qualitative narratives form the universal base layer across all topics, whereas physical metrics and analytical elements appear selectively where data routines, conventions, and organizational capabilities allow further formalization. This supports the view that qualitative reporting should not be interpreted only as a deficiency. It can also function as a practical response to complexity by reducing processing demands and enabling firms to retain interpretive control over heterogeneous or uncertain information.

Fourth, the thesis offers a capability-based explanation for the absence of explicit NEA anchoring in corporate reporting. By conceptualizing absorptive capacity as the bridge between external accounting resources such as SEEA EA and reportable ESRS categories, the findings suggest that the limited visibility of NEA is less a consequence of pure data scarcity than of an incomplete absorption chain. Even where external accounts could add value, routine use may fail because of translation effort, competence requirements, and limited integration into reporting workflows. The thesis therefore shifts the interpretation of low NEA uptake away from a simple question of managerial willingness and toward a structural problem of translation and organizational capability.

Fifth, the findings inform research on commensuration and calculative practices by showing that monetization of ES-related information is not merely a stronger form of quantification but the contested translation of heterogeneous ecological phenomena into a uniform value dimension. The concentration of monetary representations on the climate change context can be explained by the existence of relatively institutionalized valuation practices there, whereas comparable pricing infrastructures are largely absent for other ES-related topics. This also helps explain why analytical formalization is more common than monetization because it enables calculation and formalization without crossing the more contested boundary of monetary commensuration.

Finally, the thesis sharpens the distinction between reporting about ES-related issues and reporting that is explicitly anchored in accounting- and evidence-based reference frameworks. The dominance of brief or unspecific source references combined with the absence of explicit NEA references points to a persistent macro-micro mismatch. NEA logics have not yet become a routine reference infrastructure in ESRS corporate reporting. The thesis therefore provides a

theory-informed snapshot of a transitional field in which new reporting structures are emerging while the role of external accounting infrastructures, especially NEA, remains unsettled.

5.2.2. Implications for policy makers

The results indicate that standard setting can establish a common reporting structure but does not in itself produce evidence-based sustainability reporting. For policy makers and standard setters this implies the need to distinguish more clearly between specifying what must be disclosed and specifying how claims should be evidenced and made traceable. Climate change reporting is comparatively consistent because it benefits from established metrics, benchmarks, and external reference systems. By contrast, the scope, form, and source anchoring of other environmental topics under the ESRS remain highly variable, suggesting that firms revert to selective and predominantly narrative reporting where accepted measurement conventions are weak or absent. For policy makers, this means that disclosure requirements alone are insufficient if they are not accompanied by clearer expectations regarding evidence quality, methodological transparency, and traceability.

The absence of explicit NEA references further underscores the need to operationalize evidence requirements more concretely. Regulators could strengthen minimum transparency requirements by asking firms to disclose the source type of key claims as well as the underlying temporal, spatial, and methodological assumptions. Greater traceability would improve comparability and verifiability and reduce the scope of symbolic compliance. In particular, policy makers could require a clearer distinction between internally generated information, externally sourced benchmarks, and hybrid estimates based on models or proxies.

The observed macro-micro gap between NEA and corporate reporting also points to the need for translation infrastructure. Low uptake should not be interpreted as irrelevance. It often reflects translation barriers and capability constraints. Policy interventions aimed at improving connectivity could include topic-specific mapping guidance, standardized use cases, sample tables, and corporate-usable interfaces provided by national statistical offices or environmental authorities. In addition, proportional implementation through guidance documents, training, and practical support could directly address absorptive capacity constraints within firms. This would be particularly relevant for environmental topics beyond climate change, where firms appear to lack stable reporting routines and clear evidence pathways.

Finally, the findings also have implications for assurance and enforcement. As long as data quality requirements, scope boundaries, and validation expectations remain less specific for

ESRS topics E2–E5 than for climate change, assurance and enforcement are likely to remain structurally weaker in these areas. Standard setters and supervisory bodies should therefore develop more assurance-ready criteria and minimum documentation requirements for the less established environmental topics and progressively tighten consistency requirements over time, for example regarding definitions, boundaries, and methodological changes.

Overall, the findings suggest that future regulation should prioritize not only disclosure breadth but also evidence quality, traceability, and methodological transparency. This would support more decision useful sustainability reporting beyond the comparatively mature climate domain. More broadly, the results imply that strengthening nature-related reporting requires not only more mandatory topics, but also a more robust infrastructure for translating environmental information into auditable and comparable disclosures.

5.2.3. Implications for management

For management the central challenge lies not in the formal coverage of ESRS topics alone but in the substance, traceability, and consistency of the underlying evidence, especially where NEA could provide external contextual grounding. Even where environmental aspects are addressed, systematic anchoring in verifiable sources and coherent measurement logics remains limited. ESRS implementation should therefore be treated not only as a disclosure exercise but as a data and governance program. Each topic requires a documented trail covering source origin, assumptions, system boundaries, and update cycles supported by internal controls. The key managerial implication is therefore that credible reporting depends less on expanding narrative coverage and more on building repeatable internal routines for data generation, documentation, validation, and review.

The comparatively mature climate change workflow can serve as an operational template for other environmental topics. Clear responsibilities, established KPIs, targets, control processes, and external benchmarks typically underpin stronger consistency in climate disclosures. Transferring this logic to other ESRS environmental topics requires explicit accountabilities, standardized definitions and scopes, and a data catalogue that records sources, quality levels, and update cycles. Such steps would improve both reporting consistency and management steering capacity beyond climate change. In practice, this means that firms should not approach nature-related topics as isolated reporting additions, but as areas requiring the same process discipline that climate reporting has already begun to institutionalize.

The lack of explicit NEA references also suggests that external evidence is currently used selectively or only in vague form. Management should therefore establish a clearer evidence integration logic, for example through an internal evidence hierarchy that prioritizes official statistics and accounts as contextual benchmarks and plausibility checks where feasible. The value of NEA does not necessarily lie in full adoption but in its disciplined use for contextualization and validation of internal statements. Where firms rely instead on internal models or proxies, methods, limitations, and uncertainties should be documented consistently. This is important because the credibility of future nature-related reporting will depend not only on what firms claim, but also on how clearly, they can explain the evidentiary basis of those claims.

The findings further support a pragmatic layering strategy for improving disclosure quality. Narratives remain necessary to explain dependencies, causal mechanisms, and management intent, but they become problematic when they constitute the only form of evidence. A targeted upgrade strategy is therefore advisable. A stable narrative baseline should be complemented by a limited set of robust core indicators per topic, and where decision-relevant and data-feasible, by analytical elements such as risk assessments or scenario analyses. This suggests a gradual formalization pathway: firms do not need to monetize all nature-related issues, but they should progressively move from broad narrative statements toward more structured, evidence-based reporting.

Finally, the uneven thematic breadth observed in the findings suggests that nature-related dependencies and impacts are not yet fully integrated into materiality assessments, risk management, and assurance readiness. Materiality decisions should therefore be documented comprehensively including clear justifications for non-materiality. At the same time, external assurance requires an audit trail and internal controls for non-financial data. Overall, credible ESRS reporting will be achieved less through additional narrative than through repeatable data, governance, and control structures that enable comparable and verifiable nature-related disclosures beyond climate change. Management should therefore understand the current findings not merely as a reporting issue, but as an indication that internal governance systems for non-climate environmental information remain underdeveloped.

5.2.4. Implications for stakeholders

For stakeholders who use corporate reports for decision-making and engagement the results show that thematic coverage should not be equated with management maturity or

environmental performance. Given the dominance of narrative disclosures and the selective use of physical and analytical elements the mere presence of a topic provides only limited information about data robustness or managerial control. Stakeholders should therefore distinguish between the mere mention of a topic and its actual operationalization that is whether indicators, targets, responsibilities, and control mechanisms are clearly disclosed. This is especially important in the context of nature-related reporting, where selective visibility may create an impression of comprehensiveness that is not matched by equivalent evidence quality across topics.

The low visibility of NEA in corporate reporting further implies that stakeholders should scrutinize evidence anchoring more explicitly. Where firms do not refer to NEA or refer only vaguely to official data sources targeted questions become particularly important: Are NEA data or related official ecosystem accounts used to contextualize regional baselines, trends, or ecological constraints? If not, which alternative reference systems perform this function and are they methodologically comparable? Stakeholders should also ask for transparency regarding the geographic scale of claims and the translation assumptions used when linking macro-level information to firm-level contexts, for example through proxies, models, or downscaling steps.

The consistently high visibility of climate change disclosures combined with the more uneven treatment of other environmental topics also points to potential blind spots. Stakeholder scrutiny should therefore extend beyond climate change especially in areas where information gaps and low comparability are more likely. In practical terms, stakeholders can push for a small set of core indicators and consistent time series per topic supported by clear target logic and measurement rules. The findings suggest that without such scrutiny, current reporting practices may continue to privilege the most institutionalized topics while leaving other environmentally relevant areas comparatively unclear.

Finally, stakeholders should assess reliability through assurance and governance information. Where sources, assumptions, and data trails remain unclear, verifiability declines. Stakeholders should therefore scrutinize the level and scope of external assurance, what exactly has been assured, and whether internal control systems support the reported information.

Overall, sustainability reports become most decision-useful when stakeholders focus not only on thematic presence but on evidence quality, comparability, and verifiability and when they explicitly challenge the absence of NEA anchoring in cases where such external context would materially enhance credibility. More generally, the results suggest that stakeholders should read corporate sustainability reports not only as descriptions of environmental performance, but also

as selective reporting constructions shaped by differing levels of measurement maturity, institutionalization, and evidentiary support.

5.3. Limitations and future research directions

As with any empirical study, this thesis has limitations that also provide concrete starting points for further research. First, the analysis is based exclusively on publicly available corporate reports. It therefore primarily captures the external visibility of NEA/SEEA EA references in corporate sustainability reporting rather than their actual internal use. The absence of explicit NEA references cannot therefore be interpreted straightforwardly as evidence that companies do not use NEA-related information. A more plausible interpretation is the existence of a reporting-practice gap in which NEA data may be used internally, for example for contextualization, benchmarking, or internal assessments, but is not publicly disclosed or is referenced under different labels. A key avenue for future research is therefore to look behind the report through interviews, case studies, or process analyses involving reporting, controlling, and ESG data teams in order to identify where along the absorption and translation chain the integration of external accounts breaks down or remains undisclosed. Such research would be valuable because it could distinguish more clearly between non-use, indirect use, and internal use without external visibility.

Second, the study is subject to a potential visibility bias because it focuses on explicitly named source anchoring. If NEA-related inputs enter reporting only indirectly, for example through intermediaries or consultants, the degree of linkage may be underestimated. Future research could address this limitation through approaches such as semantic text analysis that identify NEA-related concepts even without explicit labels, and by examining additional disclosure channels such as methodology appendices, data books, questionnaires where sources and data trails may be documented in greater detail. This is especially relevant because external reporting may only display the final disclosure output, while the evidentiary infrastructure behind it remains partly hidden.

Third, operationalizing NEA-related anchoring as a binary presence variable is useful for assessing visible coverage, but it captures the depth and quality of integration only to a limited extent. In particular, it does not distinguish whether NEA is used merely as a contextual reference, as a methodological frame, or as an actual quantitative input into indicators, targets, or decision processes. A logical next step for future research would therefore be the development of a maturity model for NEA integration that differentiates between levels ranging

from unspecific mention to traceable and assurance-ready use. This would allow future studies to move beyond the question of whether NEA is visible at all and toward a more fine-grained assessment of how deeply it is embedded in reporting and management processes.

Fourth, the document-based and cross-sectional design does not allow robust conclusions about the drivers of low NEA visibility or weak source anchoring. Although the capability-based interpretation developed in this thesis is theoretically plausible, it cannot be tested causally with the present research design. Future studies should therefore examine barriers and enablers more directly, for example NEA data availability, regulatory guidance, assurance expectations, organizational ownership, internal competencies, and perceived decision usefulness, using surveys, comparative case studies, or mixed method designs. This would help clarify whether low uptake is primarily driven by capability constraints, weak incentives, methodological mismatch, or limited perceived relevance in corporate settings.

Fifth, the generalizability of the findings is limited by the sample, the industry composition, and the specific regulatory and reporting context considered. In particular, cross-country differences in the maturity, accessibility, and institutional anchoring of NEA are likely to shape the extent to which NEA can become visible in corporate reporting. Future research should therefore conduct cross-country comparisons between settings with differently developed NEA infrastructures in order to test whether stronger national accounting systems are associated with greater corporate uptake or more explicit reporting-level anchoring. Such comparative work would also help determine to what extent the weak visibility of NEA found in this thesis reflects a broader structural pattern or a context-specific feature of the investigated setting.

Sixth, the timing of the analyzed reports is relevant because ESRS implementation and the associated organizational routines are still evolving in many firms. Low NEA visibility may therefore partly reflect an early-stage implementation effect rather than a stable long-term pattern. Longitudinal research across multiple reporting cycles could examine whether explicit NEA referencing and evidence anchoring increase over time as reporting routines stabilize, guidance becomes more detailed, assurance practice expands, and data infrastructures improve.

Seventh, the observed macro-micro gap points to a substantive methodological challenge. Translating nationally aggregated ecosystem accounting outputs to corporate reporting contexts remains difficult even where NEA data are available due to mismatches in spatial scale, system boundaries, sector attribution, and value chain structure. Future research should therefore test concrete translation logics through mapping studies that relate specific NEA variables to

specific ESRS disclosures and make transparent where spatial, temporal, or sectoral breaks occur and which proxy approaches are practicable and methodologically robust.

Finally, limitations also arise from the operationalization of ES-related content and representation formats. Although the coding scheme provides analytical structure, classification inevitably involves interpretive judgment, particularly in borderline cases. Moreover, the present approach captures presence and form of disclosures but not their actual intensity, managerial relevance, or practical use in decision making. It also does not fully reveal whether a disclosure that appears qualitative, physical, monetary, or analytical in the final report is equally important within internal management processes. Future research could therefore refine the measurement of representation quality, for example by examining granularity, target linkage, or internal consistency, and validate coding decisions through expert review. In addition, user-oriented studies could test whether different reporting formats improve decision usefulness for relevant stakeholder groups. Future research could also build on this thesis by examining not only whether ES-relevant information is present, but which forms of representation are perceived credible, useful, and decision-relevant for preparers, assurers, and report users.

6. Use of AI

In this thesis AI-supported tools were used exclusively in a supporting capacity and served to increase efficiency in the practical work with the text material, in the coding process, and for linguistic and grammatical revision.

First, MAXQDA AI Assist was used as a tool in the context of qualitative data preparation and coding. Its use was limited to suggesting potentially relevant text passages or supporting the identification of the relevant passages. All suggestions generated by AI Assist were understood as preliminary indicators and subsequently checked manually. The final decision as to whether a text passage was relevant for coding and which category was assigned was made exclusively by manual coding based on the documented decision rules.

Second, ChatGPT, DeepL Grammarly were used to assist in the formulation and revision of text passages to improve comprehensibility, academic style, grammar, and spelling.

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Appendix

Company	Document Type	Source	Date of download
Allianz SE	Annual Report	https://www.allianz.com/content/dam/onemarketing/azcom/Allianz_com/investor-relations/en/results-reports/annual-report/ar-2024/en-allianz-group-annual-report-2024.pdf	02. November 2025
Commerzbank AG	Annual Report	https://investor-relations.commerzbank.com/media/document/b986ba5a-dc1d-41a7-a708-dc3a010ecc32/assets/Commerzbank_Group_Annual_Report_2024.pdf?disposition=inline	03. October 2025
Deutsche Bank AG	Annual Report	https://investor-relations.db.com/files/documents/other-presentations-and-events/2024/Annual-Report-2024.pdf	03. October 2025
Deutsche Boerse AG	Annual Report	https://www.deutsche-boerse.com/resource/blob/4171108/ed6eebbf4732a0df7e5338f963c388eb/data/DBG-annual-report-2024-a4.pdf	03. October 2025
Hannover Rueck AG		https://annual-report.hannover-re.com/pdf/annual-report-2024_5248.pdf	03. October 2025
Muenchener Rueckversicherungs-Gesellschaft	Annual Report	https://www.munichre.com/content/dam/munichre/mrwebsiteslaunches/2024-annual-report/MunichRe-Group-Annual-Report-2024-en.pdf/_jcr_content/renditions/original./MunichRe-Group-Annual-Report-2024-en.pdf	03. October 2025

in Muenchen AG			
Fresenius Medical Care AG	Sustainability Report	https://freseniusmedicalcare.com/content/dam/fresenius-medical-care/global/en/04_media/pdf/publications/2024/FME_Sustainability_Statement_2024_EN.pdf	03. October 2025
Fresenius SE & Co KGaA	Annual Report	https://www.fresenius.com/sites/default/files/2025-03/Fresenius_Annual_Report_2024.pdf	03. October 2025
Deutsche Telekom AG	Annual Report	https://report.telekom.com/annual-report-2024/_assets/downloads/entire-dtag-ar24.pdf	03. October 2025
SAP SE	Integrated Report	https://www.sap.com/integrated-reports/2024/en.html	03. October 2025
Scout24 SE	Annual Report	https://www.scout24.com/media/scout24/Investor_Relations/Berichte_und_Praesentationen/2024_EN/Scout24_Annual_Report_2024_EN.pdf	03. October 2025
Adidas AG	Annual Report	https://report.adidas-group.com/2024/en/_assets/downloads/annual-report-adidas-ar24.pdf	03. October 2025
Airbus SE	Annual Report	https://www.airbus.com/sites/g/files/jlcbta136/files/2025-04/Airbus%20Annual%20Report%202024.pdf	03. October 2025
BASF SE	Annual Report	https://report.basf.com/2024/en/_assets/downloads/entire-full-report-basf-ar24.pdf	03. October

			er 2025
Bayer AG	Annual Report	https://www.bayer.com/sites/default/files/2025-03/bayer-annual-report-2024.pdf	03. October 2025
Bayerische Motoren Werke AG	Annual Report	https://www.bmwgroup.com/en/report/2024/downloads/BMW-Group-Report-2024-en.pdf?page=3	03. October 2025
Beiersdorf AG	Annual Report	https://reports.beiersdorf.com/annual-report/2024/_assets/downloads/entire-beiersdorf-ar24.pdf	03. October 2025
Continental AG	Annual Report	https://annualreport.continental.com/2024/en/service/docs/annual-report-2024-data.pdf	03. October 2025
Daimler Truck Holding AG	Annual Report	https://www.daimlertruck.com/fileadmin/user_upload/documents/investors/reports/annual-reports/2024/daimler-truck-ir-annual-report-2024-incl-combined-management-report-dth-ag.pdf	03. October 2025
GEA Group AG	Annual Report	https://cdn.gea.com/-/media/investors/annual-report/2024/annual-report-2024-en.pdf?rev=db94f76a1f07427baf1ceee2811d6d67	03. October 2025
Heidelberg Materials AG	Annual Report	https://www.heidelbergmaterials.com/sites/default/files/2025-03/HM_ASR24_en.pdf	03. October 2025

Henkel AG & Co KGaA	Sustainability Report	https://www.henkel.com/resource/blob/2043310/8e58944556950ebb78141bf6a86b58a9/data/2024-sustainability-report.pdf	03. October 2025
Infineon Technologies AG	Sustainability Report	https://www.infineon.com/assets/row/public/documents/corporate/company/sustainability/sustainability-at-infineon.pdf	03. October 2025
Mercedes-Benz Group AG	Annual Report	https://group.mercedes-benz.com/documents/investors/reports/annual-report/mercedes-benz/mercedes-benz-annual-report-2024-incl-combined-management-report-mbg-ag.pdf	03. October 2025
Merck KGaA	Annual Report	https://reports.merckgroup.com/en/annualreport/2024/_assets/downloads/entire-merck-ar24.pdf	03. October 2025
MTU Aero Engines AG	Annual Report	https://www.mtu.de/fileadmin/DE/5_Investoren/Financial_Report/MTUAeroEnginesAG_AnnualReport_2024_en_locked.pdf	03. October 2025
Porsche Automobil Holding SE	Sustainability Report	https://www.porsche-holding.com/dam/files/8450d960b4fd5e65e1122a1107b13ba1492874a2/4511b3c0038ee71f4d9469543202dfcf/79e0d42e-e76a-443d-9271-9e6432dc59f4/250725_Porsche_Holding_SR_2024	13. November 2025
Qiagen NV	Sustainability Report	https://s28.q4cdn.com/125951340/files/doc_financials/2024/ar/2024-Sustainability-Statement-Final.pdf	03. October 2025
Rheinmetall AG	Annual Report	https://www.rheinmetall.com/Rheinmetall%20Group/Investor%20Relations/Ver%C3%B6ffentlichungen/Pr%C3%A4sentationen%20und%20Berichte/2025/GB/Rheinmetall-2024-GB-Annual%20Report.pdf	03. October 2025

Siemens AG	Sustainability Report	https://assets.new.siemens.com/siemens/assets/api/uuid:32a7154d-edba-47bc-8e9b-9761617ba774/sustainability-report.pdf	03. October 2025
Siemens Energy AG	Sustainability Report	https://www.siemens-energy.com/global/en/home/general/us-legal-notice-reports.html	03. October 2025
Siemens Healthineers AG	Sustainability Report	https://corporate.webassets.siemens-healthineers.com/19a152831fb49a63/3c50a8a96185/siemens-healthineers-sustainability-report-2024.pdf	03. October 2025
Symrise AG	Annual Report	https://symrise.com/corporatereport/2024/home/Symrise_Unternehmensbericht_24_EN_interaktiv_geschuetzt.pdf	03. October 2025
Volkswagen AG	Annual Report	https://annualreport2024.volkswagen-group.com/_assets/downloads/entire-vw-ar24.pdf?h=5AteXYgL	03. October 2025
Vonovia SE	Annual Report	https://report.vonovia.com/2024/q4/app/uploads/Vonovia-SE_Annual-Report-2024.pdf	03. October 2025
Zalando SE	Annual Report	https://corporate.zalando.com/sites/default/files/media-download/Zalando-SE_AGM-2025_1_Annual-report_2024.pdf	03. October 2025
Deutsche Post	Annual Report	https://group.dhl.com/content/dam/deutschepostdhl/en/media-center/investors/documents/annual-reports/DHL-Group-2024-Annual-Report.pdf	03. October 2025

E. ON SE	Annual Report	https://annualreport.eon.com/content/dam/eon-annualreport/documents/en/GB24-gesamt-EN_final.pdf	03. October 2025
RWE AG	Annual Report	https://www.rwe.com/-/media/RWE/documents/05-investor-relations/finanzkalendar-und-veroeffentlichungen/2024-gj/2025-03-20-rwe-annual-report-2024.pdf	03. October 2025
Brenntag SE	Annual Report	https://brenntagprod-media.e-spirit.cloud/06432017-be1f-41ce-8d1d-564e2a66d213/documents/corporate/investor-relations/2024/annual-report-2024/brenntag_annual-report-2024_en.pdf	03. October 2025

Table A1: Sources of the Sample

	Sample size	Provisioning Services	Regulating Services	Climate Change	Pollution	Water and Marine Resources	Biodiversity and Ecosystems	Resource Use and Circular Economy
Manufacturing	23	22 (96%)	23 (100%)	23 (100%)	15 (65%)	15 (65%)	14 (61%)	21 (91%)
Finance and Insurance	6	1 (17%)	6 (100%)	6 (100%)	1 (17%)	1 (17%)	3 (50%)	1 (17%)
Transportation and Warehousing	1	0 (0%)	1 (1%)	1 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Information	3	2 (67%)	3 (100%)	3 (100%)	0 (0%)	0 (0%)	0 (0%)	2 (67%)
Utilities	2	1 (50%)	2 (100%)	2 (100%)	0 (0%)	0 (0%)	1 (50%)	1 (50%)
Health Care and Social Assistance	2	2 (100%)	2 (100%)	2 (100%)	1 (50%)	2 (100%)	0 (0%)	2 (100%)
Real Estate and Rental and Leasing	1	0 (0%)	1 (100%)	1 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Retail Trade	1	1 (100%)	1 (100%)	1 (100%)	1 (100%)	1 (100%)	0 (0%)	1 (100%)
Wholesale Trade	1	1 (100%)	1 (100%)	1 (100%)	1 (100%)	1 (100%)	0 (0%)	1 (100%)

Table A2: Results H1 broken down by industry

	C – Information Intensity	Climate Change	Pollution	Water and Marine Resources	Biodiversity and Ecosystems	Resource Use and Circular Economy
Manufacturing	qualitative	23 (100%)	15 (100%)	15 (100%)	14 (100%)	21 (100%)
	physical	23 (100%)	10 (67%)	15 (100%)	7 (50%)	20 (95%)
	monetary	12 (52%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	analytical	18 (78%)	10 (67%)	14 (93%)	12 (86%)	8 (38%)
Finance and Insurance	qualitative	6 (100%)	1 (100%)	1 (100%)	3 (100%)	1 (100%)
	physical	6 (100%)	0 (0%)	1 (100%)	1 (33%)	1 (100%)
	monetary	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	analytical	6 (100%)	1 (100%)	1 (100%)	3 (100%)	1 (100%)
Transportation and Warehousing	qualitative	1 (100%)	n/a	n/a	n/a	n/a
	physical	1 (100%)	n/a	n/a	n/a	n/a
	monetary	0 (0%)	n/a	n/a	n/a	n/a
	analytical	1 (100%)	n/a	n/a	n/a	n/a
Information	qualitative	3 (100%)	n/a	n/a	n/a	2 (100%)
	physical	3 (100%)	n/a	n/a	n/a	2 (100%)

	monetary	0 (0%)	n/a	n/a	n/a	0 (0%)
	analytical	2 (67%)	n/a	n/a	n/a	0 (0%)
Utilities	qualitative	2 (100%)	n/a	n/a	1 (100%)	1 (100%)
	physical	2 (100%)	n/a	n/a	1 (100%)	1 (100%)
	monetary	0 (0%)	n/a	n/a	0 (0%)	0 (0%)
	analytical	2 (100%)	n/a	n/a	1 (100%)	0 (0%)
Health Care and Social Assistance	qualitative	2 (100%)	1 (100%)	2 (100%)	n/a	2 (100%)
	physical	2 (100%)	1 (100%)	2 (100%)	n/a	2 (100%)
	monetary	0 (0%)	0 (0%)	0 (0%)	n/a	0 (0%)
	analytical	2 (100%)	1 (100%)	2 (100%)	n/a	1 (50%)
Real Estate and Rental and Leasing	qualitative	1 (100%)	n/a	n/a	n/a	n/a
	physical	1 (100%)	n/a	n/a	n/a	n/a
	monetary	0 (0%)	n/a	n/a	n/a	n/a
	analytical	1 (100%)	n/a	n/a	n/a	n/a
Retail Trade	qualitative	1 (100%)	1 (100%)	1 (100%)	n/a	1 (100%)
	physical	1	0	1	n/a	1

		(100%)	(0%)	(100%)		(100%)
	monetary	0 (0%)	0 (0%)	0 (0%)	n/a	0 (0%)
	analytical	1 (100%)	0 (0%)	1 (100%)	n/a	0 (0%)
Wholesale Trade	qualitative	1 (100%)	1 (100%)	1 (100%)	n/a	1 (100%)
	physical	1 (100%)	1 (100%)	1 (100%)	n/a	1 (100%)
	monetary	1 (100%)	0 (0%)	0 (0%)	n/a	0 (0%)
	analytical	1 (100%)	0 (0%)	1 (100%)	n/a	1 (100%)

Table A3: Results H2 broken down by industry

	A – Reference to National Ecosystem Service Data	Climate Change	Pollution	Water and Marine Resources	Biodiversity and Ecosystems	Resource Use and Circular Economy
Manufacturing	Not reported	7 (30%)	14 (93%)	15 (100%)	14 (100%)	19 (90%)
	Brief statement	16 (70%)	1 (7%)	0 (0%)	0 (0%)	2 (10%)
	Systematic statement	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Finance and Insurance	Not reported	0 (0%)	1 (100%)	1 (100%)	2 (67%)	0 (0%)
	Brief statement	6 (100%)	0 (0%)	0 (0%)	1 (33%)	1 (100%)
	Systematic statement	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Transportation and Warehousing	Not reported	0 (0%)	n/a	n/a	n/a	n/a
	Brief statement	1 (100%)	n/a	n/a	n/a	n/a
	Systematic statement	0 (0%)	n/a	n/a	n/a	n/a
Information	Not reported	0 (0%)	n/a	n/a	n/a	2 (100%)
	Brief statement	3 (100%)	n/a	n/a	n/a	0 (0%)
	Systematic statement	0 (0%)	n/a	n/a	n/a	0 (0%)
Utilities	Not reported	1 (50%)	n/a	n/a	0 (0%)	1 (100%)

	Brief statement	1 (50%)	n/a	n/a	1 (100%)	0 (0%)
	Systematic statement	0 (0%)	n/a	n/a	0 (0%)	0 (0%)
Health Care and Social Assistance	Not reported	0 (0%)	1 (100%)	1 (50%)	n/a	0 (0%)
	Brief statement	2 (100%)	0 (0%)	1 (50%)	n/a	2 (100%)
	Systematic statement	0 (0%)	0 (0%)	0 (0%)	n/a	0 (0%)
Real Estate and Rental and Leasing	Not reported	0 (0%)	n/a	n/a	n/a	n/a
	Brief statement	1 (100%)	n/a	n/a	n/a	n/a
	Systematic statement	0 (0%)	n/a	n/a	n/a	n/a
Retail Trade	Not reported	0 (0%)	1 (100%)	1 (100%)	n/a	1 (100%)
	Brief statement	1 (100%)	0 (0%)	0 (0%)	n/a	0 (0%)
	Systematic statement	0 (0%)	0 (0%)	0 (0%)	n/a	0 (0%)
Wholesale Trade	Not reported	1 (100%)	1 (100%)	1 (100%)	n/a	1 (100%)
	Brief statement	0 (0%)	0 (0%)	0 (0%)	n/a	0 (0%)
	Systematic statement	0 (0%)	0 (0%)	0 (0%)	n/a	0 (0%)

Table A4: Results H3 broken down by industry