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Analysis

Circular, Green, and Bio Economy: How Do Companies in Land-Use Intensive Sectors Align with Sustainability Concepts?

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ABSTRACT

The UN Agenda 2030 deems the private sector pivotal in co-governing sustainability issues. Despite intense research on corporate sustainability there is no explicit analysis of which policy-driven concepts companies choose to forward their sustainability visions and practices. This is relevant because communication of corporate sustainability contributes to legitimizing or delegitimizing company actions, while simultaneously feeding back into public thinking and actions towards sustainability transformations. We addressed the research gap by considering three sustainability concepts mainstreamed at the global level: Circular economy (CE), Green economy (GE), and Bioeconomy (BE). Content analysis was performed on 123 reports from DJSI World companies in five land-use intensive sectors (forest, food, beverages, mining, and energy). Results suggest CE to be omnipresent and homogeneous across all companies and sectors. GE was the second most frequent concept, especially in forest and mining. BE was under-represented in all reports, with the exception of the forest sector. Interlinkages between concepts were few. The CE-BE connection appeared to be the strongest, concerning efficiency and recycling of bio-based resources. The analysis of global sustainability concepts from the perspective of corporate disclosure enables a timely discussion on the role and limits of the business organizations as a participant to sustainability transformations globally.

1. Study Rationale

In the face of pressing global social-ecological challenges ((MA, 2005); Rockstrom et al., 2009), private actors such as businesses are urged to engage in the voluntary governance of sustainability issues as key components of co-regulation, as envisioned, for instance, by the UN Agenda 2030 for Sustainable Development. Several scholars, however, have suggested that corporate sustainability would need more concrete visions and targets linked to fundamental sustainability issues in a holistic and inclusive manner (Addison et al., 2018; Bjørn et al., 2016; Lozano and Huisingh, 2011; Whiteman et al., 2013). Communication of environmental issues in corporate sustainability is often resource-focused, meaning it regards reduction of energy/material inputs and outputs, and the enhanced role of renewables (Málovics et al., 2008). According to Bocken et al. (2014, p. 42), 'Eco-innovations, eco-efficiency and corporate social responsibility practices define much of the current industrial sustainability agenda. While important, they are insufficient in themselves to deliver the holistic changes necessary to achieve long-term social and environmental sustainability'. The limits of eco-efficiency have also been highlighted by Korhonen and Seager (2008), suggesting instead to embrace a resilient approach to ecological and industrial systems. Dyllick and Hockerts (2002) have outlined six criterion corporations should satisfy as eco-efficiency, socio-efficiency, eco-effectiveness, socio-effectiveness, sufficiency and ecological equity.

Current corporate reporting shows little emphasis on reaching beyond raw-material provisioning services towards more broad regulating and cultural processes delivered by ecosystems. Furthermore, the great majority of company reports fail to acknowledge the concept of ecological limits and planetary boundaries, let alone to concretely align performance or production to such limits. Most reports particularly focus on climate change, while other ecological limits (e.g. biodiversity loss, invasive species, biochemical flows, water resources) are not represented as frequently (Bjørn et al., 2016; Whiteman et al., 2013). A study by Addison et al. (2018) showed that Fortune100 companies perform poorly in terms of disclosing measurable biodiversity impacts. Similar results were proposed by Lähtinen et al. (2016) for Dow Jones Sustainability Index (DJSI) forest companies. Málovics et al. (2008, p. 910) pointed out that even though general principles have been

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formulated to promote strong sustainability[1] in corporate governance, 'it is still very difficult for individual companies to decide the direction that should be taken in looking for a solution, since no solid guidelines have been formulated regarding the ecological limits within which companies ought to operate'.

To structure and legitimize their sustainability efforts, several companies construct their sustainability practices in reference to national or international voluntary standards, e.g. by reporting guidelines by: the Global Reporting Initiative (GRI); the International Organization for Standardization (ISO); or Organization for Economic Co-operation and Development (OECD); certification or eco-labelling, such as FSC or rainforest alliance (e.g. D'Amato et al., 2015; Lähtinen et al., 2016; Toppinen and Korhonen-Kurki, 2013). The UN Sustainable Development Goals have become a key reference point for CS (Scheyvens et al., 2016; Vildåsen et al., 2017).

During the last decades, an array of ideas and concepts has emerged from academia, industry, or political movements to support sustainability transformations by attempting to reconcile economic, social, and environmental goals. These include, for instance, the circular economy (CE), the green economy (GE), the sharing economy, the de-growth or steady-state economy, and the bioeconomy (BE) (Jackson, 2011; Loiseau et al., 2016). These concepts contribute to form companies' sustainability visions and strategies by providing shared grounds for discussion on current issues with multiple stakeholder groups. 'Considering this trend, sustainability disclosure and reporting in the future should express the extent to which companies are shifting their performance towards their chosen sustainable model' (GRI, 2015, p.8). In return, the private sector is considered a central enabler of such national and regional level sustainability policies and strategies (De Besi and McCormick, 2015; Hrabanski, 2017; Kirchherr et al., 2017).

Corporate reporting has been a central object of investigation in business, social sciences, and economics literature, the main research topics have regarded the adoption, the extent, and the quality of reporting (Hahn and Kühnen, 2013), the business case for sustainability (Kim et al., 2015; Blasi et al., 2018), the analysis of global standards, frameworks and guidelines (Boiral and Heras-Saizarbitoria, 2017; Toppinen and Korhonen-Kurki, 2013), and the semiotics and rhetorical aspects of corporate sustainability (Joutsenvirta, 2009; Milne and Gray, 2013). An important research gap, however, is the analysis of how influential global sustainability concepts mainstreamed in political discussion are internalized in businesses sustainability visions and practices (exceptions e.g. from the viewpoint of business models research, cf. Manninen et al., 2018; Upward and Jones, 2016). This is relevant for two reasons: on one hand communication of corporate sustainability is pivotal in legitimizing or delegitimizing company actions (Deegan, 2002), which is particularly critical in land-use intensive sector; on the other hand, it feeds back into public sustainability thinking and actions.

We analyse corporate sustainability reports to understand which sustainability concepts companies embrace to define and operationalize their chosen sustainability vision and related practices. In this article, we consider the three concepts that are currently most vigorously proposed at the global level, i.e. CE, GE, and BE (EAA, 2013; EC, 2015; USA, 2012; *UNEP*, 2011). To define the scope of empirical analysis, we decided to focus on five land-use intensive sectors (forest, food, beverages, mining, and energy).

To this end, we analyse corporate reports to explore the following research questions: 1. How does the frequency of CE, GE, and BE concepts vary according to the sector and geographic provenience of the companies in land-use intensive sectors?; 2. What specific elements and practices from CE, GE, and BE emerge to be emblematic or topical in each sector? Our main theoretical framing (Section 2.2) is the loop dynamic linking public and corporate discussion on sustainability, as well as the isomorphic influence among companies, particularly in the context of land-use intensive sectors.

2. Theoretical Background

2.1. Company Legitimacy and Sustainability Communication

Typically, companies operating in land use intensive sectors are influenced by important legitimacy issues with local and global stakeholders (Boiral and Heras-Saizarbitoria, 2017). Institutional theory suggests that aligning with societal norms, beliefs, values and principles contributes to legitimacy of business organizations. Legitimacy can be pursued through various isomorphic processes: accounting for the pressures exerted by external, coercive forces (e.g. the government); mimicking successful companies; and/or engaging in a professionally and socially acceptable behaviour (DiMaggio and Powell, 1983). In other words, the process of adapting to sustainability approaches at the organizational level can be viewed as a loop: powerful organizations can either force their immediate networks to adapt to their goals and procedures making them as institutional rules in the society, or they incorporate practices which are legitimated externally leading to so called isomorphic changes (Meyer and Rowan, 1977).

'Among the advantages of the legitimation process, organizations could achieve more efficient access to resources from certain stakeholders – investor funds, support from government, increased sales and customer loyalty, access to the negotiation of contracts with different suppliers and distributors, obtaining the respect and commitment of employees, etc., as a process that helps to improve the organization's economic and financial performance' (Barrena Martínez et al., 2016, p. 10). Furthermore, the perimeter of corporate sustainability is extending beyond voluntary disclosure. From 2018 onwards, the European Union (Directive 2014/95/EU) mandates companies with more than 500 employees to disclose information on policies, including outcomes regarding their environmental and social performance, and other matters relating to sustainable development.

Communication, discourse, and organizational rhetoric are fundamental aspects of legitimation, and, corporate sustainability disclosure represents a key instrument in that context (Palazzo and Scherer, 2006). To face new challenges and requirements, sustainability reporting in recent decades has undergone a deep transformation concerning contents, reporting tools, target audience, auditing, and overall design (Uyar, 2016). Currently, voluntary sustainability reporting is implemented by the means of both quantitative and qualitative data, and environmental and social information is generally published in separate reports from financial information. In addition, reporting has moved from exclusively targeting shareholders to more inclusively considering several stakeholder groups, such as customers, financers, or ENGOs (Fifka, 2012).

In addition to be subject to societal expectations, corporate sustainability communications feed into and influence societal discussion on sustainability (Signitzer and Prexl, 2008; Fuchs, 2007). Consequently, two types of dynamic take place between public sustainability discourses and corporate sustainability (Fig. 1): a top down pressure for companies to align with societal values and norms, and a bottom up corporate influence on the way sustainability is discussed and implemented in the society at large.

2.2. Circular, Green and Bio Economy

Assuming that corporations are not completely autonomous actors, and are sensitive to changing rules of the game in a society, we argue that the CE, GE, and BE are rationalized sustainability concepts that companies operating in land-use intensive sectors are driven to incorporate in their organizational conduct. Furthermore, we assume that each of these concepts builds on a unique set of sustainability dimensions and aspects.

[1] Strong sustainability, in opposition to weak sustainability, does not accept that natural, social and economic capital are interchangeable (Munda, 1997).

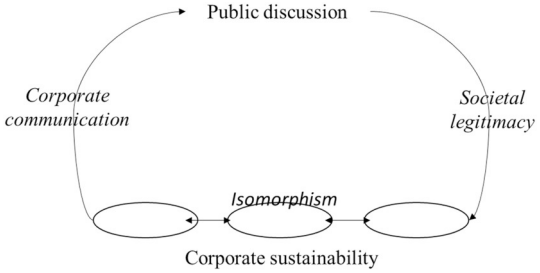

Fig. 1. The dual relationship between public discussion and corporate sustainability, with the latter characterized by isomorphic processes.

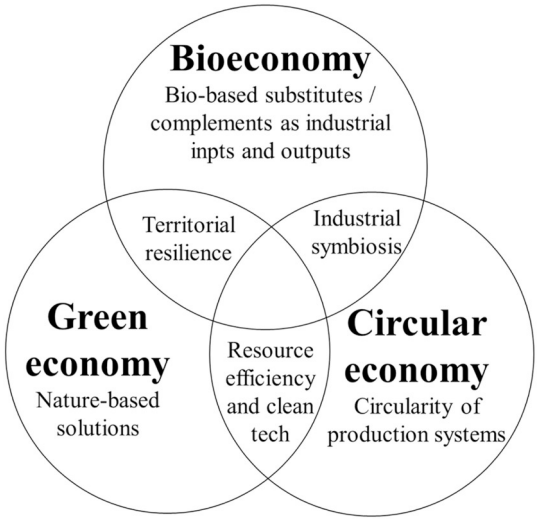

Fig. 2. The overlaps between CE, GE, and BE concepts (based on D'Amato et al., 2017).

According to recent scientific literature reviews (D'Amato et al., 2017; Loiseau et al., 2016), all three concepts tend to overlap with each other, but GE more inclusively contains elements from CE and BE (e.g. eco-efficiency; bio-based renewables). CE and BE are focused on what and how resources should be managed. GE, instead, more comprehensively acknowledges various ecological processes representing regulating and cultural ecosystem services for human beings. In addition, different actors from research, industry and policy making conceptualize and operationalize CE, GE, and BE differently. These three concepts are based upon very different sustainability visions and solutions (Fig. 2), as shown in a recent comparative analysis of these concepts in D'Amato et al. (2017). Thus, here we only introduce a brief overview of the observed differences and overlaps between these concepts.

CE is a continuation of ideas, such as industrial ecology and metabolism. It mainly advocates for closing the loop of currently linear industrial processes. The emphasis is on net reductions in production systems, through a redesign of industrial processes to minimise inputs and outputs, especially waste. Clean technologies and renewables are part of the concept (Murray et al., 2015; Korhonen et al., 2018). BE promotes the use of renewables based on biological resources, with an emphasis on the role of science-based knowledge and innovation. This emphasizes the introduction of bio-based energy and material, as well as genetic engineering dedicated to risk reduction in productive agri/environmental systems (e.g. control pests and invasive species) (Pfau et al., 2014; Bugge et al., 2016). Even though not always explicitly embedded in BE political strategies, circularity and efficiency can also be an important element (Bezama, 2016; Venkata Mohan et al., 2016). GE has been globally promoted after the after the 2012 Rio + 20 conference on sustainable development. Even though it is strongly rooted in low carbon technology and resource efficiency (*UNEP*, 2011), the more innovative aspect of GE is the idea of accounting for and enhancing natural capital as a strategic component of human well-being (Gasparatos and Willis, 2015; ten Brink et al., 2012).

3. Data and Methods

This study analyses the latest corporate reports released by companies from five land-use intensive sectors (Appendix A, Table 11). The content analysis of the reports was performed based on a codebook, which was developed through an iterative process, based on a previous systematic literature review of the CE, GE, and BE concepts, on a deliberation among the co-authors, and on an exploratory analysis of a sub-set of the data. Due to the extensive volume of data, a semi-automatized analysis was performed to calculate the frequencies and meaning of CE, GE, and BE codes in the sampled reports (Fig. 3).

3.1. Sample Selection

Our sample includes corporate sustainability reporting from 123 companies listed in the DJSI, which is often used in research to identify frontrunners for financial, social, and environmental performance (e.g. Lähtinen et al., 2016; Michelon and Parbonetti, 2012). The DJSI lists

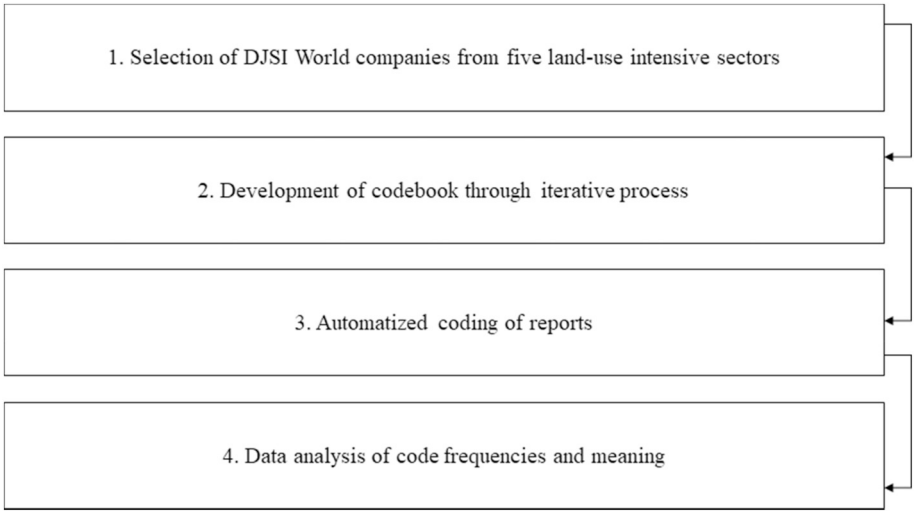

Fig. 3. The methodological process, from data collection to analysis.

companies from several sectors,[2] along with relevant information such as their geographic provenience. To restrict our analysis, we selected sectors which have a direct influence on land use, and for which all concept CE, GE, and BE are likely to be most relevant: Paper & Forest Products; Food Products; Beverages; Metals & Mining; Energy Equipment & Services (Table 1). Notably, the number of companies listed in DJSI varies according to each sector; for instance, the companies in the food sector are more numerous than those in the forest sector. The companies operate in five geographical regions based on the location of headquarters. The final sample included 2 reports from Africa, 63 from the Americas, 21 from Asia, 31 from Europe, and 5 from Oceania.

For each company, we downloaded the latest sustainability report available from the company's website. When the sustainability report was unavailable, the annual report was chosen instead. Of the initial sample, 31 reports had to be excluded because they were incompatible with the software used for the analysis. The reports in the final sample were published between 2008 and 2016. The reports' size ranged between 12 and 260 pages, which already illustrates different levels of emphasis on communicating sustainability.

3.2. The Code Book

The codebook includes codes that allow the characterisation of a certain corporate practice as belonging to one of the three concepts CE, GE, or BE. As mentioned in Section 2.2, we acknowledge that these concepts are highly fluid and bound to change over time. In addition, they include aspects and solutions oriented towards all sustainability dimensions (economic, social, and environmental). For the purpose of this study, however, we merely focused on the environmental dimension, as it has been less historically emphasized compared to the rest of the sustainability dimensions (Lozano and Huisingh, 2011). We adopt the descriptions of CE, GE, and BE from a review by D'Amato et al. (2017), which to our knowledge is the only available comparative analysis performed to date. To define each concept, we retain only the core feature that exclusively characterize CE, GE, and BE (Fig. 2, Table 2). These archetypes are needed to appropriately perform the content analysis, which requires narrowly defined categorizations of the concepts.

A main challenge was thus to develop a codebook both comprehensive and flexible enough to capture information despite the varied styles and contents of the corporate sustainability reports analysed. To guarantee a rigorous data analysis, we adopted an iterative and reflective approach to developing the codebook (Fig. 4), based on the content analysis methodology proposed by Campbell et al. (2013).

a. To determine preliminary codes that could identify CE, GE, and BE concepts, we referred to a recent systematic and comparative review of the three concepts in academic research (D'Amato et al., 2017), producing salient keywords and topics which characterize each concept. Based on such analysis we formulated a set of preliminary codes (Appendix A, Table 4).
b. Using the preliminary code book, one researcher manually coded a 65-page sub-set of the data using Atlas.ti v7.5. The sub-set was selected as follows. Using a random number generator, random pages within random reports were selected and analysed[3] (Miles and Huberman, 1984). When a new code (i.e. not present in the preliminary codebook) was identified within the analysed text, it was added to the codebook. This process was driven by the degree of saturation, i.e. when it appeared that new codes would not provide additional information. Saturation was determined by observing the cumulative trend of new sentences 'discovered' by new codes found[4] in each additional page (Appendix A, Fig. 11), and by the co-occurrences of codes.
c. Using the same software, a second coder then performed the analysis of a 5-page sub-set of data using the latest codebook available. The second researcher worked on an individual basis and without discussing the coding process with the first researcher. Intercoder reliability was then calculated with a Kappa value of 0.86. Eventual differences in coding judgments between the researchers were discussed, but there was no need to further modify the codebook (Campbell et al., 2013).

3.3. The Coding Process and Analysis

Using the final version of the codebook (Appendix A, Table 5), one researcher proceeded with coding the entire dataset with the auto-coding feature available in Atlas.ti v7.5.[5] It should be noted that even though the analysis was semi-automatized, the codes were assigned to the sentences only if relevant and meaningful in light of the context. Because each code assignment event had to be supervised by the researcher, the analysis was extremely time-intensive (with more than 13,500 events in total).

Below we provide three sentences from company C3 that illustrate in practice the differences between, respectively, CE, GE, and BE codes. 'The efficient use of energy has been an inherent operational activity and strategic aim for [the company] over many decades' (CE). 'The majority of our renewable energy comes from bagasse with smaller but increasing quantities coming from biogas which is generated on-site using anaerobic biological digestion of effluents and various wastes' (BE). 'The use of bagasse as a fuel results in the emission of carbon dioxide. However, an equivalent amount of carbon dioxide emitted in one year is captured during the next year's growth of the sugar cane crop. Therefore, the use of bagasse as a fuel is considered carbon neutral' (GE).

Ultimately, the coding process allowed to determine the frequency of CE, BE, and GE codes in each report and in the overall dataset (Joseph and Taplin, 2011). This quantifies the relative emphasis within each report on the three concepts (research question 1). The software used allowed to easily access the qualitative information behind each coded sentence by retrieving the quotations associated with each code. Based on that, we were able to provide a more in-depth understanding of the meaning and internal diversity of the qualitative content (research question 2).

3.4. Limitations

A conceptual limitation is due to our assumption that the presence/absence of CE, GE, and/or BE –related words in corporate disclosure

[2] Banks; Capital Goods; Commercial & Professional Services; Consumer Durables & Apparel; Consumer Services; Diversified Financials; Energy; Food & Staples Retailing; Food, Beverage & Tobacco; Health Care Equipment & Services; Household & Personal Products; Insurance; Materials; Media; Pharmaceuticals, Biotechnology & Life Sciences; Real Estate; Retailing; Semiconductors & Semiconductor Equipment; Software & Services; Technology Hardware & Equipment; Telecommunications; Transportation; Utilities.

[3] We avoided selecting more than one page from the same report. If the selected page contained no sustainability information, it was discarded, and a new page was selected.

[4] Every time a new code was found, a score was attributed to the code as follows: score 1 was attributed if the sentence in which the new code was first found was not covered by the existing codes; score 0 was attributed if the sentence was covered by existing codes. Sentences are intended as titles or as phrases which terminate with a full stop.

[5] The following settings were used: case sensitive, 'confirm always', 'create quotation from match extended to sentence'. This means that sentences are chosen as unit of measurement, and each sentence is searched for all the possible codes. The same sentence can disclose information about more than one concept (CE, GE, BE). Non-textual formats such as figures and tables are also considered, as long as they contain text material. Each code matched by the auto-coding software needs to be verified by the researcher before it is assigned.

Table 1
Initial and final sample used in the study. The initial sample includes companies listed in DJSI World, while the final sample excludes some companies for which reports could not be retrieved or were not compatible with the software used.

Number of companies	Paper & Forest Products	Food Products	Beverages	Metals & Mining	Energy Equipment & Services	Total
Initial sample	9	64	29	31	21	154
Final sample	9	54	16	28	16	123

Table 2
Descriptions of the three concepts (CE, GE, and BE) adopted in this study.

Concept	Description of proposed solutions
CE	Technological or other artificial solutions aimed at accounting for and reducing resource use and consumption, improve resource use efficiency and recycling, and minimise waste and emissions. Foster industrial symbiosis of productive processes, where an industry by-product is another industry input.
GE	Ecology-oriented solutions aimed at accounting for impacts and dependencies on ecosystems and related services; avoiding, minimising or offsetting impacts on such systems, preserving or enhancing the functionality and resilience of ecological systems, with a landscape perspective.
BE	Technological or other artificial solutions aimed at complementing or substituting non-renewable resources with bio-based alternatives. Innovation and research and development are key, e.g. improving the productivity of species and variety by means of genetic engineering.

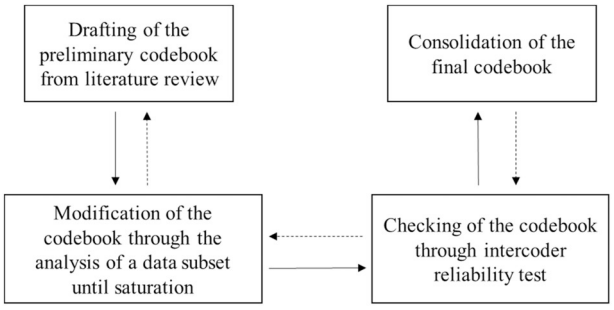

Fig. 4. The development of the codebook.

provides an accurate indication of company alignment with such concepts. This assumption can of course be challenged. Also, we do not validate the quality or the level of critical thinking in the reports in comparison to company profiles, media analysis, or other possible means of information. However, similar methods and assumptions have however already adopted in the analysis of corporate sustainability (e.g. Bjørn et al., 2016) and other text analysis studies (e.g. Abson et al., 2014). With this study merely focusing on the environmental dimension, aspects related to social and economic sustainability were excluded, which can be considered as a shortcoming, but was necessitated by the available resources to conduct the coding.

Technical limitations include the following. Corporate sustainability reports are released on voluntary basis, and therefore they do not adopt the same standard in terms of length, structure, and content, even though they may align with globally recognized guidelines. When performing a content analysis, non-standardization of reports may hamper a fully systematic comparison (Kristofik et al., 2016). Moreover, not all company reports were published in the same year. Our data, spanning from 2008 to 2016, might exclude developments in reporting after recent national or regional strategies for BE and CE (e.g. EC, 2015), or after the most recent GRI 4 guidelines launched in 2016.

Even though the codebook was developed through an iterative process by drawing from theory and data to make it as inclusive as possible, it may not be fully exhaustive, and using a software auto-coding feature implies a marginal possibility that some information is missed. Because the coding process is supervised by a researcher, there is also the possibility for human errors (i.e. that some codes are attributed or not attributed erroneously). Despite this physiological limitation, auto-coding is useful to process big volumes of data that would be otherwise be too time consuming to analyse (e.g. Bjørn et al., 2016; Vidal and Kozak, 2008). Furthermore, given the high number of codes attributions, we can assume that eventual errors do not ultimately affect the overall results.

4. Results

4.1. General Overview

CE is by far the most frequent concept reported in all land-use intensive sectors (73% of the total codes), followed by GE (21%) and BE (5%) (Table 3). A similar frequency pattern occurs in each individual sector, with the exception of the energy sector, where GE and BE have almost the same frequencies (only 3% and 4% respectively). The forest sector is where GE and BE codes occur more frequently, followed by the food and beverages sectors. Notably, BE is virtually absent in the mining sector, while GE represents almost a third of the total codes.

The analysis of the geographical distribution of the data shows only little variation in the codes frequency (Fig. 5). BE is mentioned twice as frequently (measured per page) in Europe as compared to Asia, and three times more frequently compared to the Americas. However, almost 90% of the total BE codes from European companies are recorded in three forest companies. The remaining 28 European companies from the food, beverages, mining, and energy sectors hardly ever mention BE.

Content-wise, CE is the most consistent of the concepts, present in all five sectors and with three regular themes: monitoring resource use, reducing resource use, and recycling of resources. These themes generally consider both materials and energy use, as well as inputs and outputs (raw materials, water, energy, waste). GE can be summarized by four themes, which are however not always present in all sectors. The themes include the accounting for, avoiding, and reversing operation impacts; managing land and resources sustainably, e.g. through

Table 3
CE, GE, and BE frequencies for each sector.

Codes	Paper & forest products	Food products	Beverages	Metals and mining	Energy & equipment services	All sectors
CE	45%	84%	86%	68%	94%	73%
GE	31%	13%	11%	31%	3%	21%
BE	24%	3%	4%	0%	4%	5%

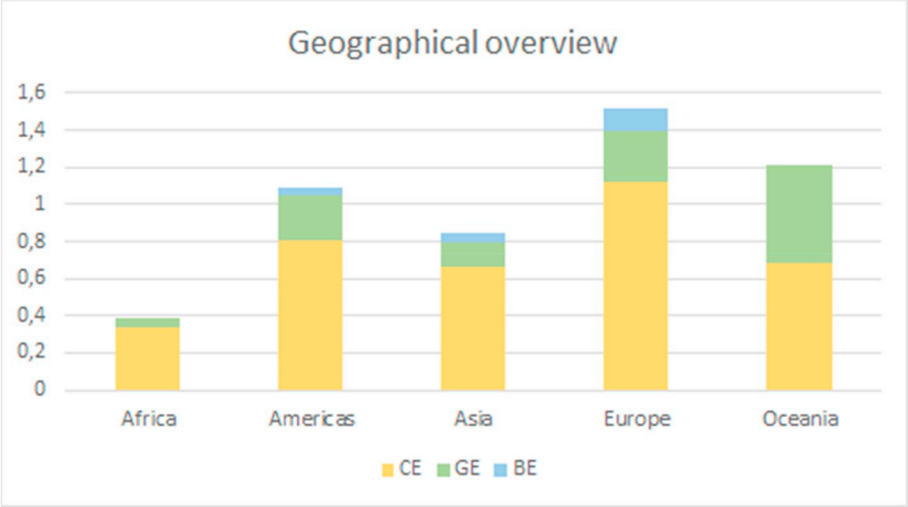

Fig. 5. Average frequency per page according to company geographical provenience for all five sectors.

an ecosystem approach and nature-based solutions; protecting and enhancing biodiversity, ecosystems are related services; and involving stakeholders in managing surrounding ecosystems with a landscape approach. BE is thematised into bio-based energy and fuels; bio-based materials and compounds; and biosecurity (e.g. genetic improvement of crops).

4.2. Paper & Forest Products

On average, CE occurs as frequently as 1.3 times per page in the forest sector, while GE and BE occur 0.9 and 0.6 times respectively (Fig. 6). The frequency pattern of the three codes is similar for all companies, even though C7 and C8 seem to dedicate more space to GE and BE respectively. Much variation in CE, GE, and BE disclosure is observed among different companies.

CE in the forest sector is about monitoring inputs and outputs, fostering resource efficiency (energy, water, raw materials), recycling, and reducing emissions and waste (e.g. use of residues, sidestreams) (Appendix A, Table 6). GE disclosure emphasizes sustainable forestry, avoiding or minimising operations in natural areas of high ecological value, protecting or restoring ecosystems and related services, monitoring and conservation of biodiversity (especially native wildlife and endangered species), and involving local stakeholder groups in a landscape management approach. Regarding BE, key areas of discussion include the energy and fuels from fiber biomass, as well as bio-based materials and compounds and genetic improvement of trees. Interlinkages between CE and BE relate to the efficient use and recycling of bio-based resources: energy self-sufficiency through wood-based energy and cascading use of wood. In addition, a reference to both BE and GE is found in the context of carbon sink functions provided by standing and harvested wood, and no connection is found between CE and GE.

4.3. Food Products

On average, CE occurs as frequently as 0.7 times per page in the food sector, while GE and BE are less frequent (0.1 and 0.02 times respectively) (Fig. 7). The frequency pattern of the three code is similar for all companies. The level of BE discussion is very low throughout the sector, and only few companies mention BE at all (in particular companies C10, C11, C13, C14, C15, C16).

Disclosure on CE is, as for the other sectors, highly frequent. Notably, some areas of distinction include design and packaging, which allow for reductions in resource consumption or facilitate recycling

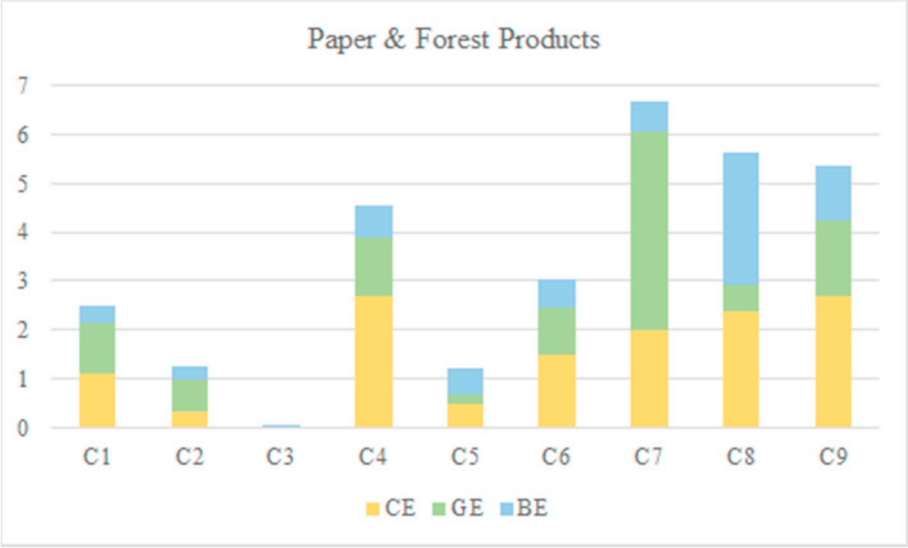

Fig. 6. Average frequency per page for the companies in the Paper & Forest Products sector.

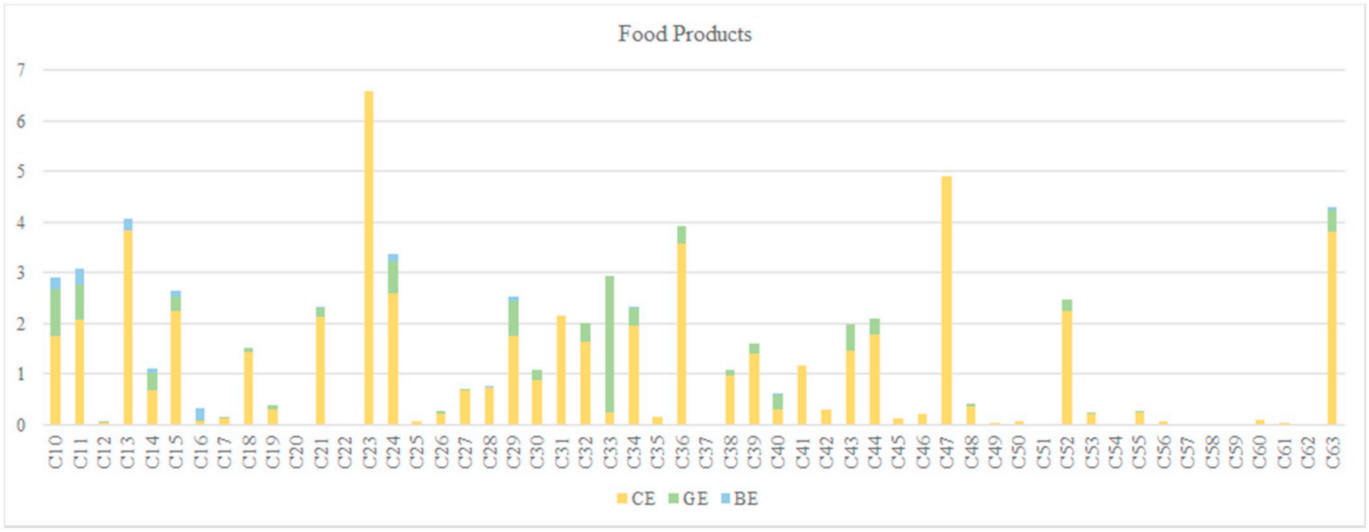

Fig. 7. Average frequency per page for the companies in the Food Products sector.

(Appendix A, Table 7). Furthermore, some companies emphasize reducing food consumption and waste through capacity building with customers (education, information), nudging of consumers (e.g. portioning and taste) and by donating excess food to local communities. GE in the food sector is, similar to the forest sector, dominated by avoidance or mitigation of operation impacts on biodiversity and ecosystems, sustainable management of intensive systems (e.g. agro-forestry), acknowledging social and economic value of ecosystem services, as well as nature stewardship, protection, and conservation. The stock levels of natural populations harvested for food production, as well as pollinators' populations for crop production are the most emblematic topics to the sector. BE appears to be about energy and fuel from biomass, innovative biotech-based food products, and bio-based packaging.

The interconnections between CE and BE include ideas such as, improved eco-design of bio-based products, producing bio-based energy from waste, or improved recyclability of bio-based products compared to fuel-based ones. An example linking BE and GE is found in the idea of bio-based products from sustainability-managed ecosystems. The idea of bio-cycles, found in one company only, might actually comprise all three concepts—CE, GE and BE. In fact, bio-cycles are described as the cycles through which biomass (e.g. sugar cane) is processed to produce a main product (sugar), while by-products are used to produce organic fertilizers that are applied to sugar cane crops: '…various initiatives that make full use of energy and food resources without waste, such as bio-cycles' (C10). Another example referring to CE, GE, and BE together, relates to the idea of packaging made of recycled fibres from sustainably managed ecosystems: '[The company] will source 100 percent of our fiber-based packaging by 2020 from recycled material or from virgin wood fiber regions that are known to not be contributing to deforestation (any high-risk regions will be independently verified)' (C24).

4.4. Beverages

In the beverage sector, CE dominates the sustainability communication (1.3 times per page), followed by GE (0.17) and BE (only 0.05) (Fig. 8). BE is virtually non-existent (except for C68, C74, and C78), and GE is also disclosed very scarcely.

Content-wise, frequency of CE codes relates to the same ideas recurring in the other sectors, such as efficiency and recycling. All themes from GE are also found, and similar to the forest and food sectors, the beverages sector relies directly on natural capital (Appendix A, Table 8). Thus, in addition to impact avoidance or offsetting, and to mere nature stewardship, several reports also emphasize the sustainable management of land and resources in coordination with other stakeholder groups at the landscape level. Although few companies mention BE, the beverages sector provides interesting examples on bio-based energy, material and chemical innovations, as well as biosecurity solutions. Links between CE and BE are found in relation to the use of biomass by-products for energy production or for animal feed production. Interestingly, no connection was recorded between GE and CE or BE in the beverages sector.

4.5. Metals & Mining

Similar to the other sectors, sustainability disclosure in the mining sector is dominated by CE, but BE is present in only 7 out of 28 companies (Fig. 9). This is understandable since we are dealing with a sector not relying on bio-based materials. However, the GE concept represents almost a third of the codes, the highest individual score (together with the forest industry) among all five sectors. A certain level of variation in GE disclosure is present among the companies.

In addition to the traditional themes found under CE (Appendix A, Table 9), a specific element recorded in the mining sector is the idea of urban mining, which reclaims metals from urban waste products or buildings. The consistent emphasis on GE is related to nature conservation, avoided impacts or ecosystem rehabilitation after mining operation. In comparison to the other sector, the theme of sustainable land use and natural resource management is missing, since mining companies do not directly rely on natural capital. References to BE practices are minimal, which is not surprising considering that the mining sector is not considered as bio-based (Asada and Stern, 2018): in addition to bioenergy-related projects, an interesting case is bioleaching. A couple of companies referred to the production of biomass-based bags (C100), and to artificial insemination programmes for cattle (C92), but these were development programmes involving local communities on a philanthropic basis, thus relating more to the social dimension. No practices linking BE with CE or GE were found. Connections between CE and GE were found regarding the impacts of CE practices (e.g. water abstraction or wastewater disposal) on ecosystems.

4.6. Energy Equipment & Services

The energy sector records the lowest score for GE disclosure (3%), while frequency of BE codes is minimal (4%). Sustainability-related information is thus completely dominated by CE (Fig. 10). Only 3 out of 16 companies mention any reference to BE, but most of the BE codes are recorded in the report by company C113.

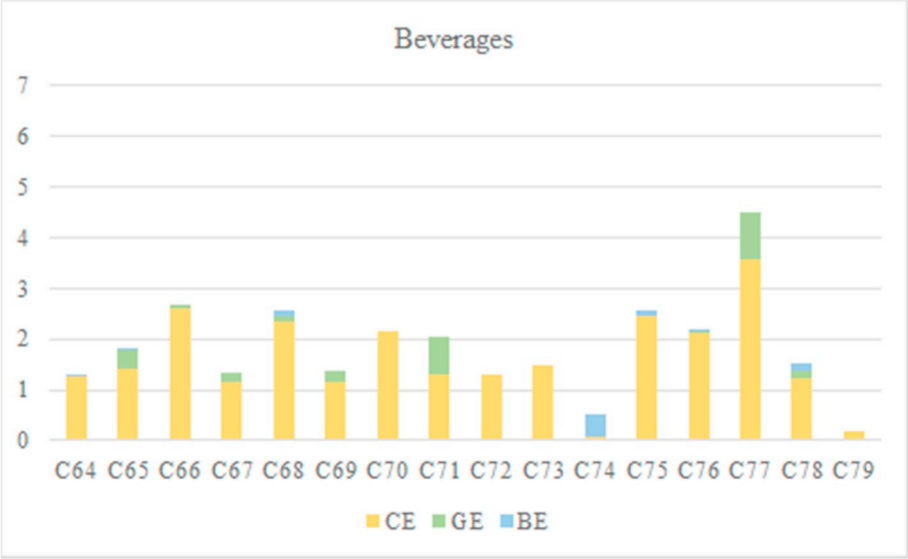

Fig. 8. Average frequency per page for the companies in the Beverages sector.

The usual CE themes, omnipresent in all sectors, are consistently discussed in the energy sector as well (Appendix A, Table 10). References to GE are minimal, and similar to the mining sector, sustainable land and natural resource use, as well as stakeholder involvement for ecosystem management at the landscape level are missing. Frequency of BE is also extremely limited, in addition to a few references to biofuels and biochemicals, company C113 provides an example of biosecurity (a fungicide). In fact, in addition to lithium technology, the company also deals with chemicals for agricultural solutions as well as health and nutrition.

5. Discussion

Overall, the internalization of different sustainability concepts by land use intensive companies can be interpreted in light of the policy and industry diffusion of such concepts, and the relevance for the specific sector. Indisputably, CE is the most ubiquitous concept, and the most frequently mentioned across all sectors and companies. This was not surprising, as the existing literature has shown that CE practices are abundantly discussed in corporate sustainability literature, such as eco-innovations and eco-efficiency (Bocken et al., 2014; Korhonen and Seager, 2008). Several explanations can contribute to clarify the dominance of CE in the field of corporate sustainability. First, it is the concept with the largest body of scientific literature, recording an increase in academic popularity since the early 2000s (D'Amato et al., 2017). Second, in opposition to other schools of sustainable thought, CE 'has largely emerged from legislation' (e.g. in China), rather than academic or political movements (Murray et al., 2015, p. 373). Third, CE is more directly (compared to GE and BE) related to reducing costs, fostering innovation, and improving existing practices by means of engineer-based solution (Guenster et al., 2011). Fourth, CE practices directly respond to sustainability issues that have been traditionally flagged by international reporting guidelines (e.g. GRI), such as water inputs, waste, carbon and pollutant emission (D'Amato et al., 2015, 2018). Companies are therefore particularly keen on addressing such issues to secure their legitimacy. In particular, CE can be directly linked to practices addressing climate change (energy savings, emission reductions). Climate change is perceived as a much more pressing issue at societal level, compared to, for instance, biodiversity loss (Legagneux et al., 2018).

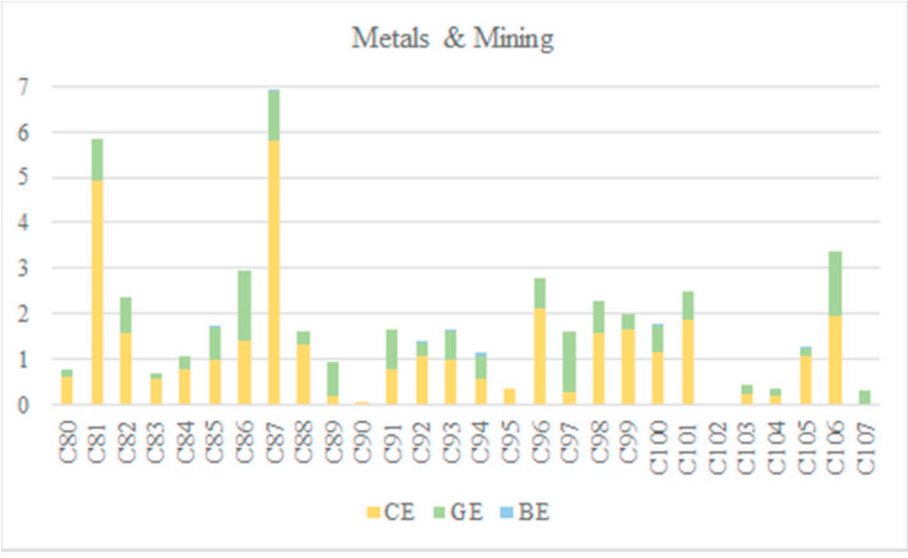

Fig. 9. Average frequency per page for the companies in the Metals & Mining sector.

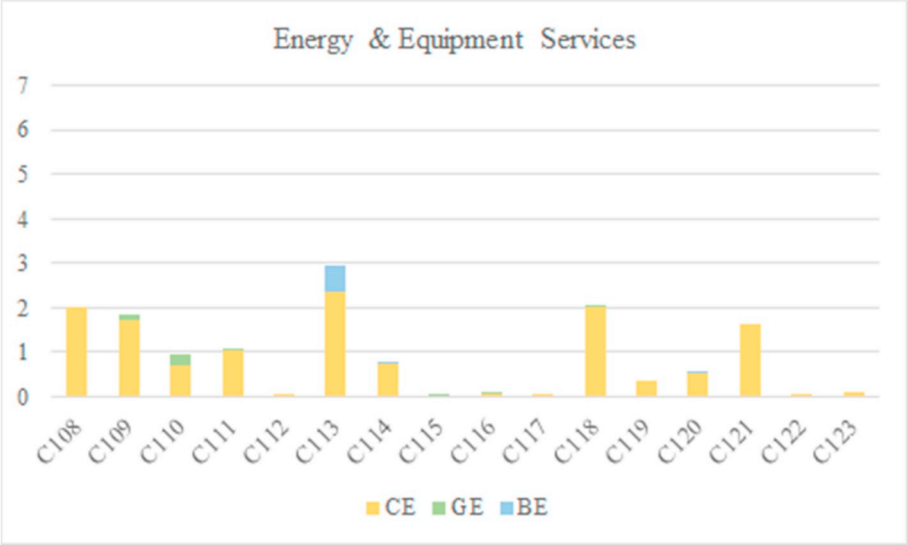

Fig. 10. Average frequency per page for the companies in the Energy & Equipment Services sector.

GE is the second most frequently mentioned concept; it has become rather popular in academia and policy making, thus trickling down to corporate sustainability, after the 2012 UN Conference on Sustainable Development in Rio de Janeiro (Rio + 20) (Hrabanski, 2017). GE practices in corporate sustainability include accounting strategies such as assessing impacts and (less often) dependencies; and response strategies such as avoiding, minimising, or offsetting impacts, and conserving or enhancing ecosystems and related services to reduce risks deriving from dependencies (D'Amato et al., 2018; D'Amato et al., 2015; Gasparatos and Willis, 2015; Hanson et al., 2012). Thanks to the political visibility of the new ideas brought about by GE, 'private industry was able to strengthen and legitimize its actions in favour of market-based environmental governance' (Hrabanski, 2017, p. 605). GE is especially found in the forest and mining sectors. These two sectors, in fact, are active in communication about their efforts towards biodiversity conservation practices due to legitimacy issues with stakeholders ranging from local communities to the broader public (Boiral and Heras-Saizarbitoria, 2017).

BE is the most recent concept to have emerged in the context of economic and societal strategies towards sustainability transformations. This contributes to explaining its poor representation in corporate reports from all sectors, with the exception of the forest sector, where in fact, BE is currently vividly discussed (Hetemäki, 2017; Roos and Stendahl, 2015). Nonetheless, the very low frequencies found in the food and energy sector were unexpected. BE strategies rely on sourcing biomass from primary production systems such as forestry, agriculture, and fisheries (Asada and Stern, 2018), thus the food sector should be pivotal to its development (Bugge et al., 2016; De Besi and McCormick, 2015). Furthermore, because so much of the current discussion around BE regards sustainability of biomass-based energy and fuels, companies operating in the energy sector were also expected to dedicate more attention to this concept. Like the other concepts, also BE may hold potential from the perspective of communication and legitimacy. A study on the Swedish forest sector, suggests that engaging with BE is likely to contribute to company legitimacy because the concept 'brings closer, rather than antagonises' different societal actors (Hodge et al., 2017, p. 582).

Content-wise, three CE themes can be identified and are omnipresent and abundantly discussed across companies and land-use intensive sectors: 1) monitoring/assessing; reducing/optimizing; 2) recycling/reusing of energy; and 3) material flows. The scientific literature often criticizes CE for its purely mechanistic perspective in addressing industrial processes, which addresses economic and environmental sustainability but lacks a solid connection to the social dimension (Murray et al., 2015). Our analysis reveals that a few food companies provided examples that connect CE's environmental sustainability to the social dimension, such as reducing food consumption and waste through nudging of consumer behaviour (e.g. portioning, taste), thereby redistributing excess food to local communities. In other sectors, CE is connected to the society through developing recycling practices and infrastructure together with the customers and communities.

Four themes are found in GE: 1) accounting, avoiding, and offsetting operational impacts; 2) managing land and resources sustainably (e.g. through an ecosystem approach and nature-based solutions); 3) conserving biodiversity and ecosystems both for altruistic reasons and to enhance ecosystem services beneficial to company operations (e.g. pollination for food production); 4) engaging stakeholders in landscape-level ecosystem management. Similar themes are found by Boiral and Heras-Saizarbitoria (2017) in their analysis of biodiversity-related practices emerging from corporate reports from the forest and mining sector.

Three BE themes are found in our analysis of the reports: bio-based energy and fuels; higher value use of biomass (bio-based materials and composites); and biosecurity, emerging especially in forest and food sectors. Biosecurity is about addressing risks in agri-environment systems caused by pests/diseases, invasive species, natural hazards, or changes in environmental conditions. A similar or complementary idea is also found in GE, which presents aspects dedicated to territorial and crop adaptation and resilience. However, CE and BE engage in different strategies for biosecurity. For instance, crop resistance to pests can be enhanced through biological control (GE) or by genetic manipulation to select the most resistant clones (BE); reduction of water requirements can be operated by planting the varieties that are most suitable for the ecological characteristics of the area (GE) or by engineering drought resistant clones.

Few interlinkages between CE, GE, and BE can be found in the reports. CE and BE connections are those occurring most often across three different sectors (forest, food, and beverages) and regard the efficient use and recycling of bio-based resources. This is in line with the principle of waste hierarchy and the cascading use of biomass promoted at the EU level (EC, 2018), implying a prioritization of higher value uses of biomass before energy production under efficient use and recycling practices.

A notable difference between the use of the concepts is that while BE and especially CE are used to address packaging and transport,

focusing on multiple stages of the supply chain, GE is more confined to land-use issues. The relevance of GE for company viability is highlighted in the disclosure more indirectly in terms of dependencies on natural capital and ecosystem services, as also suggested by relevant scientific literature (TEEB, 2012; Winn and Pogutz, 2013). None of the concepts CE, GE, and BE explicitly address the idea of responsible consumption, even though CE at times includes some elements towards this, such as product longevity or resource efficiency for user benefit. In addition, according to the scientific literature, the role of citizens/consumers and the idea of frugality remains weak within these concepts (D'Amato et al., 2017; Hobson and Lynch, 2016). Related to this, all CE, GE and BE concepts are limited in addressing the degrowth paradigm. An extensive review showed that scientific literature dealing with CE, GE or BE generally largely excludes degrowth topics (D'Amato et al., 2017).

These observations raise the questions on whether and how CE, GE and BE can really represent solid avenues towards strong sustainability. In particular, as an emerging concept, BE would benefit from a deeper discussion regarding the difficulty to deliver sustainability solely by replacing fossil-based resources with bio-based ones. In fact, BE strategies exclusively aimed at managing ecosystems for biomass production can conflict with other environmental and social goals (Pfau et al., 2014). With GE being the only concept expanding beyond a resource-oriented approach, corporate sustainability still deeply fails to address planetary boundaries and more broadly the Sustainable Development Goals (Whiteman et al., 2013; Haffar and Searcy, 2018).

6. Conclusions

Emerging global sustainability concepts currently popularized in academia and policy-making are trickling-down to the way companies define, operationalize, report on, and ultimately legitimize sustainability in their visions and practices. Our results and discussion bring novel insight about what kind of rhetoric companies choose to communicate and feed into the societal discussion in regard to the politically-driven sustainability concepts of CEGEBE (Palazzo and Scherer, 2006; Signitzer and Prexl, 2008; Fuchs, 2007). We remark that these considerations are important since private sector is deemed central for the development all CE, GE, and BE strategies at national and regional level, and vice versa these concepts guide corporate sustainability communication strategies.

At the corporate sustainability management level, we would expect communication of GE- and especially BE-related information to increase in quantity and quality in the future; this process would be driven by the need to align company sustainability strategies with emerging sustainability ideas, which are being mainstreamed in policy making and academia, and thus guarantee legitimization with multiple stakeholders. The inclusion of more information about GE and BE in corporate reporting is likely to provide a more inclusive account of sustainability in land-use intensive sectors. For instance, discussion on BE can lead to further insights regarding the origin, health and safety issues of bioresources used along international value-chains (bio-based energy and fuels, as well as higher value use of biomass such as bio-based materials and composites).

Considering the multiple limitations regarding the ability/effectiveness of CE, GE and BE concepts and related policies to foster strong sustainability transformations, global Sustainable Development Goals represent, at the moment, the ultimate benchmark to help corporate sustainability navigating across multiple and evolving concepts and ideas. However, a tension remains between the ideas of sustainability which are legitimated by society (and thus internalized by companies) and those advanced by scholars or activists (Buch-Hansen, 2018). For instance, the contribution of the Sustainable Development Goals to pursuing strong sustainability is questioned by some in light of the fact that they do not open any space for discussing development models other than growth. Further considerations on the potential of diffusion of degrowth thinking in industrial settings similar this study would require developing a separate code-set systemizing dimensions of its key ideas at the company level.

To further investigate the connection between corporate sustainability management and the way it feeds into public discussion through multidimensional CE, GE, and BE concepts, additional research could focus on the following areas. i. Trends in sustainability concepts adopted by firms (considering disclosure practices also in non-DJSI companies), with longitudinal data from corporate disclosure material, as well as other sources such as elicited knowledge from managers and experts. ii. The quality, veracity and effectiveness of the disclosed information (also in light of the evolving conceptualization of sustainability ideas) and how such disclosure is perceived among external stakeholder groups. iii. The relationship between the financial performance and company levels of sustainability disclosure, with a focus on which and how sustainability concepts are adopted. iv. Alignment of company and industry strategies with targets set at national and regional level for CE, GE, and BE policies.

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Appendix A

Table 4
The preliminary codebook, including codes and terms them.

Primary code (concepts)	Terms to identify codes
CE	recycl*|re-us*|reuse*|reusing|eco-design|reduc*|replac*|*efficien*|remanufacte*|re-manufact*|less|output|byproduct|by-product|waste|emission|CO*|carbon|symbiosis|circular|circular economy
GE	conserv*|restor*|steward*|ecosystem*|biological divers*|biodivers*|CO*|habitat*|native*|species|weed*|disease*|natural*|sustainable land|environmental service*|green economy|
BE	renewable*|biotechnology*|crop*|fiber*|cellulo*|biotech*|biomass|biofuel*|yield|biorefin*|bio-based|biocompos*|byproduct*|by-product*|biogas|*compound*|innov*|oil*|biosecurity|bioeconomy| bio-economy|

Table 5
The final codebook, including codes and terms them.

Primary code (concepts)	Terms
CE	*efficien*|*cycl*|by-product|byproduct|carbon|circular|circular economy| CO*|consum*|decreas*|dispos*|durab*|eco-design*|ecodesign*|electric*|emission*|energ*|fuel*|gas*|ghg|greenhouse|heat*|landfill|least|less*|linear*|longev*|loss|low*|material*|maxim*|minim*|nutrient*|offset*|optim*|output*|power|preserv*|recov*|reduc*|remanufact*|re-manufact*|repair*|replac*|residu*|reus*|re-us*|sav*|shelf-stabl*|symbiosis|utili*|wast*|*water*|withdraw*|zero
GE	*plant*|agric*|agroforest*|animal*|biodivers*|biolog*|biome| carbon|CO*|catchment|conserv*|corridor*|crop*|degrad*|destroy*| disease*|*disturb*|ecolog*|ecosystem*|endanger*|endemic*|environmental service*|erosion|farm*|fauna|flood*|flora|fragile|green economy|groundwater*|habitat|indigeno*|insect*|invasive*|land manag*|land use*|landscape|mitigat*|native*|natural*|nexus|organic|organism*|pest* |phyto*|pollinat*|population*|preserv*|preven*|pristine|protect*|recla* |regener*|rehab*|remed*|reserv*|resilien*|restor*|runoff|sensitiv*|soil |species|steward*|sustainable land|threat*|vegetation|vulnerab*|water|wild*|weed*
BE	alternative*|bio*|breed*|crop*|by-product*|byproduct*|cellulo*|clone*|compound*|diesel*|diseas*|electric*|energ*|fiber*|fibre*|fung*|genetic*|hybrid*|innov*|insect*|oil*|pest*|petroleum*|plant*|pulp*|renewab*|replac*|resistan*|toleran*|vegetable*|water-based|weed*|wood-based|yield

Table 6
Events coded on CE, GE, and BE from the reports of the companies in the Paper & Forest Products sector.

CE	
Assessing and monitoring resource use	'The sulphur dioxide emissions were 0.42 kilograms per tonne of product in 2015, a 64% reduction compared to 2014' (C1).
	'Effluent load (COD) reduced 40% by 2030' (C8).
Reducing resource use	'Reductions in energy requirements of products and services' (C6).
	'Reduction in solid waste generation' (C7).
Recycling and recovering resources	'Recycled and virgin fibres complement each other in papermaking; the fiber lifecycle becomes longer when paper is recycled, thus leading to a better use of the forestry resources' (C1).
	'We continue to explore opportunities for increasing water recovery from the mill's production processes' (C4).
GE	
Accounting for, avoiding, minimising or offsetting operations in natural areas	'Total number of IUCN red list species and national conservation list species with habitats in areas affected by our operations' (C7)
Sustainable land use and resource management, and nature-based solutions	'Our challenge is to meet the increasing demand for products from sustainable forestry practices that generate income and improve livelihoods for the communities they serve, while still providing important ecosystems services, including biodiversity, stabilising soils and regulating climate and water flows' (C4).
Biodiversity and ecosystem (services) stewardship and conservation	'There are 5 endangered species of native flora and another two declared as vulnerable in the CMPC's forest lands, which are protected' (C1).
	'Promote environmental restoration of 40,000 hectares of its own areas between 2012 and 2025' (C2).
Stakeholders engagement for ecosystem management at landscape level	'Participating farmers select parts of their lands to be used for plantation forestry, in return for financial compensation' (C6).
BE	
Bio-based energy and fuels	'Reducing our carbon footprint also presents opportunities for the business through the sale of green energy and green fuels, and contributes to our self-sufficiency in electricity as our mills can generate excess energy from biomass' (C4).
Bio-based materials and compounds for new products and services	'We want to offer products that incorporate new technologies, such as biomaterials, biocompounds, and biofuels. […] Pulp and black liquor may be broken down into other products with higher value added, in a move to expand our production line' (C2).
	'As a renewable natural resource wood represents a favourable alternative to materials based on fossil fuels' (C6).
	'The product segments are chemical building blocks, lignin products, biofibrils and biomedical products' (C8).
Biosecurity	'As a part of our breeding programme we are investigating the use of modern breeding tools, including marker assisted breeding and genetic engineering' (C6).
	'When establishing plantation units with these [clonal] compounds, the company increased genetic variability and consequently reduced the risk of loss associated with environmental stress, pests, or disease caused by climate change.' (C2).
CE & BE	
Efficient use and recycling of bio-based resources	'In adopting the cascading use of wood principle, we aim to optimise our own use of virgin and recycled fibres.' (C4).
	'In particular, we are on track to become energy self-sufficient at all of our mills through the introduction of new biomass boilers and enhancement of existing energy systems' (C4).
	'For many years we've focused on increasing energy efficiency throughout all of our operations and have expanded our focus to include increasing the use of bioenergy from wood waste wherever possible' (C9).
CE & GE	
NA	NA
BE & GE	
Carbon sinks from standing and harvested biomass	'Trees absorb carbon dioxide (CO2) from the atmosphere, and together with wood-based products act as carbon sinks' (C6).

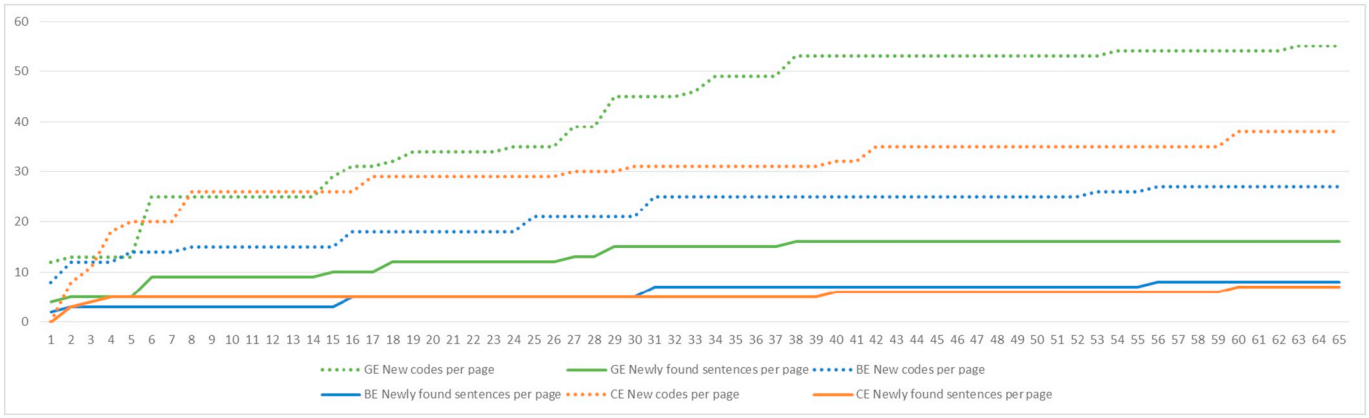

Fig. 11. Cumulative trend of new sentences 'discovered' by new codes in each additional page of the data subset.

Table 7
Quotes about CE, GE, and BE from the reports of the companies in the Food Products sector.

CE	
Assessing and monitoring resource use	'In order to monitor the Group's impact on the environment, key bakery production metrics have been established for monitoring electricity consumption, gas consumption, wastewater intensity and overall carbon emissions, which are reported to executive management and the Board of Directors on a regular basis' (C12).
	'To monitor and measure improvements and GHG reductions, we focus on intensity reduction (lowering the ratio of energy use per ton of product produced)' (C55).
Reducing resource use	'[The company] has been actively working over the years to develop 'resource-saving fermentation technologies,' such as efficient fermentation technologies using less raw materials and manufacturing methods that use raw materials without competing with food resources' (C10).
	'When we reduce the weight of our packaging, we cut post-consumer waste as well as improve the efficiency of our logistics by reducing transport movements' (C13).
	'Water-saving projects include switching from wet-cooling to dry-cooling systems, which use air instead of water (C14).
	'Having achieved significant efficiencies through our ecodesign tools and by using best-in-class materials and technologies, further progress every year is increasingly challenging (C44)'.
Recycling and recovering resources	'The How2Recycle label helps consumers understand how to dispose of each component within the package system, and whether it is widely collected or not' (C21).
	'We took these inputs into account in our K-Cup® pod design to make recycling easy, but there is more we can do to increase recovery rates for small items of value' (C36).
GE	
Accounting for, avoiding, minimising or offsetting operations in natural areas	'The Company monitors the impacts and scope of its areas covered by environmental conservation and preservation policies' (C15).
	'…development of the Natural Capital Protocol, which will help organisations understand, measure and value their impacts and dependencies on the natural environment, and are one of 10 companies testing the first draft.' (C44)
Sustainable land use and natural resource management, and nature-based solutions	'Given the marked decline in skipjack catches in waters around Japan since the latter half of the 2000s, the goal is to contribute to the sustainable development of the skipjack fishing industry and fishing communities in Japan, which play an important role in Japan's dietary culture. Given the marked decline in skipjack catches in waters around Japan since the latter half of the 2000s, the goal is to contribute to the sustainable development of the skipjack fishing industry and fishing communities in Japan, which play an important role in Japan's dietary culture' (C10).
	'We also develop innovative agroforestry projects to increase biodiversity on cocoa farms' (C14).
Biodiversity and ecosystem (services) stewardship and conservation	'Many of our products contain honey, fruits, vegetables and other ingredients that require pollination […] to improve pollinator habitats and increase tomato yields' (C24).
Stakeholders engagement for ecosystem management at landscape level	'To date, we have contributed almost $1 million to the Brazilian sustainable farming group to promote the adoption of sustainable soybean farming practices that can improve yields and prevent expansion into ecologically sensitive areas' (C11).
BE	
Bio-based energy and fuels	'The majority of our renewable energy comes from bagasse with smaller but increasing quantities coming from biogas which is generated on-site using anaerobic biological digestion of effluents and various wastes' (C13).
Bio-based materials and compounds for new products and services	'any of these chemicals, made from starch and oilseed-based feedstocks, are in the early development phase, while others area approaching the pilot-plant demonstration phase' C11.
	'…a promising pipeline of algae-based oil and ingredient products' (C16).
	'…uses self-renewing bacteria to convert the whey byproduct from Greek style yogurt production into a combustible biogas' (C24).

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Table 7 (*continued*)

	'Alternative Ink on Boxes and Cartons Water-based and vegetable inks provide an environmentally friendly alternative to traditional petroleum-based inks' (C29).
	'The labels are made with biomass plastic, of which at least 50% is comprised of plant-derived raw material, a renewable resource, and which boasts exceptional environmental suitability particularly in terms of curbing CO2 emissions and reducing consumption of petroleum and other items' (C63).
Biosecurity	'… the development of genetically modified organisms (GMOs) offers the potential for increased agricultural productivity and improved nutritional value that can enhance human health and development' (C24).
CE & BE	
Efficient use and recycling of bio-based resources	'Previously, the emphasis was on developing environmental packaging designs before product use, such as thinner, lighter, smaller containers and packaging, biomass plastics use, and improved loading efficiency' (C10).
	The methane generated from the biogas is fed into a combined heat and power plant (CHP), generating green electricity with additional heat recovery from the exhaust' (C13).
	'…we produce electricity from burning of sugarcane bagasse (the fibrous portion of the sugarcane that remains after the extraction of sugarcane juice) […] in boilers, which enables our mills to meet their energy requirements' (C16).
	'The alternative inks reduce Volatile Organic Compound emissions, reduce worker exposure to petroleum oils, and make it easier to recycle paper than petroleum-based ink' (C29).
CE&GE	
	NA
BE&GE	
Bio-based products from sustainability managed ecosystems	'These products use packaging material that contains pulp from ecological forest thinning' (C10).

Table 8
Quotes about CE, GE, and BE from the reports of the companies in the Beverages sector.

CE	
Assessing and monitoring resource use	'Our robust environmental management system focuses on helping the business achieve its targets for water efficiency, water wasted at water-stressed sites, water quality, water replenishment, carbon emissions, waste to landfill and sustainable packaging' (C71).
Reducing resource use	'Our new freezers ensure energy savings of up to 30% compared with the previous models' (C64).
	'In 2016, we will implement updated and extended operational standards on energy, water and wastewater globally, and accelerate our plans to deliver innovative and best practice solutions on efficient resource use' (C68).
	'This includes minimizing the natural resources we consume, being as efficient as possible with those that we use, and reducing their associated environmental footprint' (C75)
Recycling and recovering resources	'We faced drought and water scarcity in some of our brewery locations around the world, which has encouraged us to take new and innovative approaches to our water efficiency resulting in savings of over 14 million hectoliters between 2014 and 2015' (C65).
	'We investigated the opportunity for recycling glass waste back into new bottles, and, through our supply network, we established that we were already successfully doing this and reducing our demand for raw materials' (C66).
	'While our American White Oak barrels can only be used once in our process, we sell used barrels to other distilleries that reuse them to mature their products' (C67).
	'Design our packaging to be recoverable or recyclable, and support increased recycling rates' (C76).
GE	
Accounting for, avoiding, minimising or offsetting operations in natural areas	'We have established a process to assess the impact of our operations on biodiversity and aim to deploy this approach at all our major sites' (C71).
	'The health of that ecosystem depends on the sum of our actions.' (C76).
Sustainable land use and natural resource management, and nature-based solutions	'What we're trying to do is identify those varieties that can maintain agronomic yield, when we apply as much as a 40% reduction in water' (C65).
Biodiversity and ecosystem stewardship and conservation	'Deepening people's relationship with nature is perhaps the most significant outcome of our joint restoration project at the Woodford Reserve Distillery, where in the first phase we planted trees to restore habitat along Glenn's Creek' (C67).
	'Non-native plants and trees have been replaced with indigenous natives to improve biodiversity and as a result many native species of frogs, fish and waterbirds have returned to the area' (C77).
Stakeholders engagement for ecosystem management at landscape level	'Through the program, we provide farmers and landowners financial incentives, known as Payment for Environmental Services (PES), that encourage environmentally responsible land management and the conservation of natural resources in order to prevent erosion and sediments' (C65).
	'Once farmers are able to use a small plantation area to grow more valuable products, they will no longer need to expand their farmland by trespassing into the forest'.(C78).

(*continued on next page*)

Table 8 (*continued*)

BE	
Bio-based energy and fuels	'We introduced a 50,000-liter biodiesel station in the Zarate brewery in Argentina to refuel delivery trucks' (C65).
	'This project is focused on burning the by-product alcohol in boilers together with fuel oil' (C78).
	'One innovative way of getting more value from our raw materials is to recover organic carbon from brewer's used grains and yeast, and use it to produce biogas, which is an excellent source of clean, renewable energy' (C68).
Bio-based materials and compounds for new products and services	'Our partnership […] is all about developing the world's first fully biodegradable and bio-based wood-fibre bottle for beverages' (C68).
	'… [the company] decided to enter the pharmaceuticals business, which it positioned as a new field in which it could leverage the biotechnologies cultivated in beer production' (C74).
Biosecurity	'For example, the development of products in cooperation with Kasetsart University involves formulating soil supplements based on the bio-mass cycle' (C78).
CE & BE	
Efficient use and recycling of bio-based resources	'One innovative way of getting more value from our raw materials is to recover organic carbon from brewer's used grains and yeast, and use it to produce biogas, which is an excellent source of clean, renewable energy' (C68).
	'The recovery of biogas for generating heat or electricity to use in our processes is a more efficient use of natural resources and is Carbon neutral' (C75).
	'By-product from our facilities will be used as raw material in animal feed production' (C78).
CE & GE	
NA	NA
BE & GE	
NA	NA

Table 9
Quotes about CE, GE, and BE from the reports of the companies in the Metals & Mining sector.

CE	
Assessing and monitoring resource use	'Our average greenhouse gases (GHG) emission intensity (tonnes of CO2 equivalent per tonne of ore processed) for all our operating mines in 2015 was 0.0200, a modest 2% reduction from' (C80).
	'The Group reports its water footprint – including their extraction sources and consumption levels – using the water CDP programme methodology' (C84).
Reducing resource use	'The plan includes a GHG emissions reduction strategy with both mid- and long-term targets' (C85).
	'This has meant a significant reduction in the amount of water we draw from local rivers and other freshwater sources' (C100).
Recycling and recovering resources	'The recovered slurry is pumped to the re-treatment (C82)'.
	'We are committed to implementing the International Council of Mining and Metals Sustainable Development Framework, which requires us to facilitate and encourage responsible design, use, reuse, recycling and disposal of our products throughout the supply chain' (C86).
	'The Precious Metals Recycling Division of Ohkuchi Electronics Co., Ltd., a SMM Group company, collects, separates and mills urban mine raw materials including precious metals, then roasts and dissolves them using acids and alkali to effectively recover and concentrate precious metals for reuse as alloys in other metals at our Toyo Plant' (C105).
GE	
Accounting for, avoiding, minimising or offsetting operations in natural areas	'the […] mines discharge into wetland areas, none of which is considered environmentally sensitive or listed as protected wetland' (C80).
	'Research and biodiversity monitoring protocols are used to understand and measure long term biodiversity trends' (C82).
	'Rehabilitate degraded ecosystems or restore cleared ecosystems following exposure to impacts that cannot be completely avoided and/or minimized' (C85).
	'All operations to develop dedicated biodiversity management plans, including controls to prevent, minimise, rehabilitate and offset impacts' (C87).
	'Under the mitigation hierarchy, when avoidance is not possible we identify measures aimed at minimising impacts and implementing best practice rehabilitation programmes' (C101).
Sustainable land use and resource management, and nature-based solutions	NA
Biodiversity and ecosystem (services) stewardship and conservation	'In addition to conserving habitats and protecting species of concern, the Biodiversity Action Plan explicitly addresses the need to support local residents in deriving sustainable benefits from the ecosystem' (C89).
Stakeholders engagement for ecosystem management at landscape level	'Through many discussions with multiple stakeholders, we developed a greater understanding of how we might impact the water quality and integrity of the ecosystem in which we operated' (C88).
BE	
Bio-based energy and fuels	'Purchased and started using steam from biomass fuel' (C105).

(*continued on next page*)

Table 9 (*continued*)

Bio-based materials and compounds for new products and services	'…use of bioleaching to extract copper, which has proven to be highly efficent' (C94).
	'Jute produced will be used to produce biodegradable bags and sacks for sale in Abidjan and beyond' (C100).
Biosecurity	'Artificial insemination programmes for genetic improvement, involving over 1,700 dairy cows from 570 separate producers in the surrounding area' (C92).
CE & BE	
NA	NA
CE & GE	'The new plans also preserved lake levels, requiring no additional water withdrawal and calling for the quick return of unused minerals to the lake to maintain salinity levels' (C88).
	'The Group's wastewater disposal volumes do not exceed the approved limits, including admissible impact limits, or have any major impact on biodiversity of water bodies and related habitats' (C96).
NA	NA
BE & GE	
NA	NA

Table 10
Quotes about CE, GE and BE from the reports of the companies in the Energy & Equipment Services sector.

CE	
Assessing and monitoring resource use	'CGG has been measuring and monitoring the fuel intensity of its marine seismic surveys for several years' (C110).
	'For the onshore energy usage, the Company uses the World Resources Institute Greenhouse Gas Protocol (GHG Protocol) method to calculate CO2 equivalents' (C119).
Reducing resource use	'This has resulted in a reduction of almost 65% of the water normally used in this process' (C111).
	'20% reduction in water use intensity in high-risk areas' (C113).
Recycling and recovering resources	'Recycling volumes improved 120%, and our top recycled materials are solvents (33%), metals (30%), and containers (20%)' (C108).
	'Over the 2012–2014 periods we disposed of approximately 65,000 tons per year of non-hazardous waste, of which nearly 60 percent was recycled' (C109).
GE	
Accounting for, avoiding, minimising or offsetting operations in natural areas	'We conduct environmental due diligence prior to new site acquisitions, even lease sites, to identify any sensitive ecosystems or other fragile environmental conditions' (C109).
	'Soft-starts are used as a standard mitigation measure to warn marine mammals and sea turtles of our presence before surveying begins, giving the animals time to leave the immediate vicinity of our operation prior to our vessels reaching full power' (C110).
Sustainable land use and resource management, and nature-based solutions	NA
Biodiversity and ecosystem (services) stewardship and conservation	'Wildlife protection, including regulations that ensure our activities do not jeopardize endangered or threatened animals, fish and plant species, nor destroy or modify the critical habitat of such species' (C116).
Stakeholders engagement for ecosystem management at landscape level	NA
BE	
Energy and fuels	'Biomass-based fuel - These include, but are not limited to wood, sawdust, grass cuttings, biodegradable domestic refuse, charcoal, agricultural waste, crops and dried manure' (C121).
Materials and compounds for new products and services	'We introduced three new biologicals – materials originating from renewable plant or natural microbial sources – to our comprehensive line of crop protection products' (C113).
	'…a biodegradable fluid designed to be collected and distributed in disposal fields where naturally occurring microorganisms degrade the components' (C114).
Biosecurity	'The new biological fungicide […] can help growers yield an average of 9.5 more bushels per acre of corn than untreated fields' (C113).
CE & BE	
NA	NA
CE & GE	
NA	NA
BE & GE	
NA	NA

Table 11
List of companies included in the analysis.

Company	Headquarters	Sector	Publication year	Type of report
Agnico Eagle Mines Limited	Canada	MNX Metals & Mining	2015	Sustainability report
Ajinomoto Co	Japan	FOA Food Products	2016	Sustainability report
Alcoa Inc	United States	ALU Aluminum	2016	Sustainability report
Ambev S.A.	Brazil	BVG Beverages	2015	Sustainability report
Anglo American Plc	United Kingdom	MNX Metals & Mining	2015	Sustainability report
AngloGold Ashanti Ltd	South Africa	MNX Metals & Mining	2015	Sustainability report
Anheuser Busch Inbev NV	Belgium	BVG Beverages	2015	Sustainability report
Antofagasta Hldgs	United Kingdom	MNX Metals & Mining	2015	Sustainability report
Archer-Daniels-Midland Co	United States	FOA Food Products	2014	Sustainability report
ARYZTA AG	Switzerland	FOA Food Products	2015	Annual report
Associated British Foods	United Kingdom	FOA Food Products	2016	Sustainability report
Baker Hughes Inc	United States	OIE Energy Equipment & Services	2015	Sustainability report
Barrick Gold Corp	Canada	MNX Metals & Mining	2015	Sustainability report
Barry Callebut AG Reg	Switzerland	FOA Food Products	2014–2015	Sustainability report
BHP Billiton Ltd	Australia	MNX Metals & Mining	2016	Sustainability report
Boliden AB	Sweden	MNX Metals & Mining	2015	Sustainability report
BRF S.A.	Brazil	FOA Food Products	2015	Annual report
Britvic	United Kingdom	BVG Beverages	2015	Sustainability report
Brown-Forman Corp A	United States	BVG Beverages	2015–2016	Sustainability report
Bunge Ltd	United States	FOA Food Products	2015	Annual report
Calbee Inc	Japan	FOA Food Products	2016	Annual report
Cameron International Corp	United States	OIE Energy Equipment & Services	2014	Sustainability report
Campbell Soup Co	United States	FOA Food Products	2016	Sustainability report
Carlsberg AS B	Denmark	BVG Beverages	2015	Sustainability report
China Mengniu Dairy Co. Ltd.	China	FOA Food Products	2008–2013	Sustainability report
CJ CheilJedang Corp	Republic of Korea	FOA Food Products	2015	Sustainability report
Coca-Cola Co	United States	BVG Beverages	2015–2016	Sustainability report
Compagnie Generale de Geophysique-Veritas	France	OIE Energy Equipment & Services	2013	Sustainability report
Compass Minerals Intl	United States	MNX Metals & Mining	2014	Sustainability report
ConAgra Foods Inc	United States	FOA Food Products	2016	Sustainability report
Constellation Brands Inc. A	United States	BVG Beverages	2016	Sustainability report
Core Laboratories N.V.	United States	OIE Energy Equipment & Services	2016	Sustainability report
Diageo Plc	United Kingdom	BVG Beverages	2016	Sustainability report
Dr Pepper Snapple Group	United States	BVG Beverages	2015	Sustainability report
Empresas CMPC SA	Chile	FRP Paper & Forest Products	2015	Sustainability Report
Ensco PLC - CL A	United States	OIE Energy Equipment & Services	2015	Annual report
Ezaki Glico Co	Japan	FOA Food Products	2016	Annual report
Fibria Celulose S.A.	Brazil	FRP Paper & Forest Products	2015	Integrated report
First Quantum Minerals Ltd	Canada	MNX Metals & Mining	2016	Sustainability report
Flowers Foods Inc	United States	FOA Food Products	2015	Sustainability report
FMC Technologies Inc	United States	OIE Energy Equipment & Services	2015	Sustainability report
Fomento Economico Mexicano S.A.B. de C.V.	Mexico	BVG Beverages	2015	Sustainability report
Franco-Nevada Corp	Canada	MNX Metals & Mining	2015	Annual report
Freeport-McMoRan Inc	United States	MNX Metals & Mining	2015	Sustainability report
General Mills Inc	United States	FOA Food Products	2016	Sustainability report
Glanbia Plc	Ireland	FOA Food Products	2015	Annual report
Glencore Plc	United Kingdom	MNX Metals & Mining	2015	Sustainability report
Goldcorp Inc	Canada	MNX Metals & Mining	2015	Sustainability report
Gruma SAB B	Mexico	FOA Food Products	2014	Annual report
Grupo Bimbo S.A.B.	Mexico	FOA Food Products	2015	Annual report
Grupo Mexico SAB de CV B	Mexico	MNX Metals & Mining	2015	Annual report
Grupo Nutresa S.A.	Colombia	FOA Food Products	2015	Sustainability report
Hain Celestial Group Inc	United States	FOA Food Products	2015	Sustainability report
Halliburton Co	United States	OIE Energy Equipment & Services	2015	Sustainability report
Helmerich & Payne Inc	United States	OIE Energy Equipment & Services	2016	Annual report
Hershey Foods Corp	United States	FOA Food Products	2015	Sustainability report
Hormel Foods Corp	United States	FOA Food Products	2015	Sustainability report
Ingredion Inc	United States	FOA Food Products	2015	Sustainability report
IOI Corp Bhd	Malaysia	FOA Food Products	2016	Sustainability plan
Kellogg Co	United States	FOA Food Products	2015–2016	Sustainability report
Kerry Group A	Ireland	FOA Food Products	2015	Annual report
Keurig Green Mountain Inc	United States	FOA Food Products	2015	Sustainability report
Kewpie Corporation	Japan	FOA Food Products	2015	Annual report
Kikkoman Corp	Japan	FOA Food Products	2015	Sustainability report
Kirin Holdings Co Ltd	Japan	BVG Beverages	2015	Sustainability report
Korea Zinc Co	Republic of Korea	MNX Metals & Mining	2015	Annual report
Lindt & Sprungli AG Ptg	Switzerland	FOA Food Products	2015	Sustainability report
Louisiana Pacific Corp	United States	FRP Paper & Forest Products	2015	Annual report
Marine Harvest ASA	Norway	FOA Food Products	2015	Annual report
McCormick & Co	United States	FOA Food Products	2015	Sustainability report
Mead Johnson Nutrition Co	United States	FOA Food Products	2014	Annual report
Molson Coors Brewing Co B	United States	BVG Beverages	2015	Sustainability report
Mondelez International Inc	United States	FOA Food Products	2015	Sustainability report
Mondi Plc	United Kingdom	FRP Paper & Forest Products	2015	Sustainability Report

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Table 11 (*continued*)

Company	Headquarters	Sector	Publication year	Type of report
Nestle SA Reg	Switzerland	FOA Food Products	2015	Sustainability report
Newcrest Mining Ltd	Australia	MNX Metals & Mining	2015	Sustainability report
Newmont Mining Corp	United States	MNX Metals & Mining	2015	Sustainability report
Nippon Meat Packers Inc	Japan	FOA Food Products	2016	Annual report
Nissin Food Products Co	Japan	FOA Food Products	2016	Annual report
Noble Corp plc	United States	OIE Energy Equipment & Services	2015	Annual report
Norilsk Nickel PJSC	Russian Federation	MNX Metals & Mining	2015	Sustainability report
Norsk Hydro AS	Norway	ALU Aluminum	2015	Annual report
Oceaneering Intl Inc	United States	OIE Energy Equipment & Services	2015	Annual report
Oji Holdings Corp	Japan	FRP Paper & Forest Products	2016	Integrated report
ORION Corp.	Republic of Korea	FOA Food Products	2015	Sustainability report
Orkla AS	Norway	FOA Food Products	2015	Annual report
PepsiCo Inc	United States	BVG Beverages	2015	Sustainability report
Pernod-Ricard	France	BVG Beverages	2013	Sustainability report
Petrofac	United Kingdom	OIE Energy Equipment & Services	2015	Sustainability report
Pinnacle Foods Inc	United States	FOA Food Products	2015	Annual report
Post Holdings Inc.	United States	FOA Food Products	2016	Annual report
Randgold Resources Ltd	United Kingdom	MNX Metals & Mining	2015	Sustainability report
Rio Tinto Ltd	Australia	MNX Metals & Mining	2015	Sustainability report
Saputo Inc	Canada	FOA Food Products	2016	Annual report
SBM Offshore NV	Netherlands	OIE Energy Equipment & Services	2015	Annual report
Silver Wheaton	Canada	MNX Metals & Mining	2015	Annual report
Smucker J.M. Co	United States	FOA Food Products	2016	Sustainability report
South32 Limited	Australia	MNX Metals & Mining	2016	Annual report
Southern Copper Corp	Peru	MNX Metals & Mining	2015	Annual report
Stora Enso OYJ R	Finland	FRP Paper & Forest Products	2015	Sustainability Report
Sumitomo Metal Mining Co	Japan	MNX Metals & Mining	2016	Sustainability report
Suzano Papel e Celulose S.A. Prf A	Brazil	FRP Paper & Forest Products	2015	Sustainability Report
Tate & Lyle	United Kingdom	FOA Food Products	2016	Annual report
Technip SA	France	OIE Energy Equipment & Services	2015	Sustainability report
Teck Resources Limited Class B SV	Canada	MNX Metals & Mining	2015	Sustainability report
Tenaris SA	Italy	OIE Energy Equipment & Services	2015	Sustainability report
Thai Beverage	Thailand	BVG Beverages	2015	Sustainability report
The Kraft Heinz Company	United States	FOA Food Products	2016	Annual report
Tiger Brands Ltd	South Africa	FOA Food Products	2015	Sustainability report
Tingyi (Cayman Islands) Holdings Corp.	China	FOA Food Products	2015	Annual report
Toyo Suisan Kaisha	Japan	FOA Food Products	2015	Annual report
Transocean Ltd	United States	OIE Energy Equipment & Services	2016	Annual report
Treasury Wine Estates	Australia	BVG Beverages	2016	Annual report
TreeHouse Foods Inc	United States	FOA Food Products	2015	Annual report
Turquoise Hill Resources Ltd	Canada	MNX Metals & Mining	2013	Sustainability report
Tyson Foods Inc. A	United States	FOA Food Products	2016	Annual report
UPM-Kymmene Oyj	Finland	FRP Paper & Forest Products	2015	Annual report
Want Want China Holdings Ltd.	China	FOA Food Products	2015	Annual report
West Fraser Timber Co Ltd	Canada	FRP Paper & Forest Products	2015	Sustainability Report
WH Group Ltd	China	FOA Food Products	2015	Annual report
WhiteWave Foods Co	United States	FOA Food Products	2015	Annual report
WOOD GROUP (JOHN) PLC	United Kingdom	OIE Energy Equipment & Services	2015	Annual report
Yakult Honsha Co	Japan	FOA Food Products	2016	Sustainability report

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