



Biodiversity accounting and reporting: A systematic literature review and bibliometric analysis

Goizeder Blanco-Zaitegi^{a,*}, Igor Álvarez Etxeberria^b, José M. Moneva^c

^a Department of Financial Economics I, Faculty of Economics and Business, University of the Basque Country UPV-EHU, Avda. Lehendakari Aguirre 83, 48015, Bilbao, Spain

^b Department of Financial Economics I, Faculty of Economics and Business, University of the Basque Country UPV-EHU, Plaza de Oñati 1, 20018, San Sebastián, Spain

^c Department of Accounting and Finance, Faculty of Economics and Business, University of Zaragoza, Gran Vía 2, 50005, Zaragoza, Spain

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ABSTRACT

Towards the improvement of environmental sustainability and the conservation of biodiversity, organisations are increasingly aware of the importance of reporting their impacts on biodiversity and the conservation plans undertaken. Biodiversity accounting and reporting are relevant for developing organisational practices oriented towards environmental sustainability, promoting cleaner management policies with less impact on the environment. Biodiversity accounting research has attracted scholars in business management and accounting, and as a result, the literature in the field has grown in recent years. This study analyses the intellectual structure of the biodiversity accounting and management discipline through a systematic literature review, along with bibliometric techniques based on a co-word analysis of the main keywords included in 63 publications. The results reveal five thematic clusters: one motor cluster (sustainability), two transversal clusters (biodiversity reporting, corporate biodiversity management) and two isolated clusters (environmental protection, emancipatory accounting). In addition, the content of the selected papers is analysed and promising research paths are found, such as the need for more robust quantitative analyses or the development of new forms of emancipatory accounting. The study discusses the main insights from the analysis, proposes future research directions and provides practical implications for biodiversity protection and environmental sustainability.

1. Introduction

Human domination over the past centuries has seriously affected the environmental well-being of the planet (Rockström et al., 2009). Researchers agree that the Holocene era is over and a new geological era has begun (Steffen et al., 2015), the Anthropocene, a term first assigned by Crutzen (2002). Researchers have identified nine planetary boundaries (Rockström et al., 2009), which are critical to maintain the stability of the Earth system (Steffen et al., 2015). Below the identified boundaries (i.e., the safe zone), the risk of destabilisation of the Earth system due to anthropogenic disturbances is likely to remain low, but if the proposed limits are exceeded, there is a serious risk of collapse of the entire system (Steffen et al., 2015). One of these nine boundaries, biodiversity loss (Rockström et al., 2009), also referred to as biodiversity integrity (Steffen et al., 2015), is considered a core boundary and has already entered the danger zone (Rockström et al., 2009). Since all boundaries within the Earth system are interconnected (Rockström

et al., 2009), the accelerated loss of biodiversity threatens the ability of the other biophysical processes to remain within the safe zone (Steffen et al., 2015).

The planet Earth is currently facing a serious environmental collapse due to the rapid loss of biodiversity over the last centuries. Researchers agree that this accelerated destruction is an indicator that suggests that a period of mass extinction of species (i.e., the sixth mass extinction) is under the way (Barnosky et al., 2011). While humans have increased their population tenfold over the past three centuries (Crutzen, 2002), other species are at serious risk of extinction (Ceballos et al., 2015). Climate change, habitat fragmentation, pollution, invasive species, mono-agriculture, overfishing or poaching are the main stressors that threaten biota (Barnosky et al., 2011). According to Ceballos et al. (2020), the destruction of habitats and wildlife trade for human consumption of food and medicine may be linked to the current coronavirus disease (Covid-19) and without proper bans on these practices, humanity is not safe from future pandemics.

* Corresponding author. Department of Financial Economics I, University of the Basque Country UPV-EHU, Bilbao, Spain.

E-mail addresses: goizeder.blanco@ehu.es (G. Blanco-Zaitegi), igor.alvarez@ehu.es (I. Álvarez Etxeberria), jmmoneva@unizar.es (J.M. Moneva).

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Organisations, as important agents of the society, are accountable for their actions and therefore play a key role in the overall sustainability of the planet. International initiatives, such as, the Global Reporting Initiative (GRI) or the International Integrated Reporting (IIR) Framework, had made possible the development of more sustainable Corporate Social Responsibility (CSR) reporting practices (Gray, 2006). Accountants, as essential agents in companies and non-corporate organisations, are responsible for reporting environmental and social activities (Bebbington, 2001) and therefore, the information disclosed by them could affect and influence the perceptions of stakeholders (Gray, 1992). In this regard, information related to biodiversity should also be included in the organisations' sustainability reports. Biodiversity reporting practices have improved considerably, due in part to GRI biodiversity indicators that made it easier for accountants to disclose biodiversity issues (Boiral, 2016).

In the last decades, social and environmental accounting has gained attention in academic research. Although at first glance the increase in social and environmental accounts could mean that companies are more transparent and accountable for sustainability (Gray, 1992), researchers are concerned that this is not always the case (Gray, 2006). The criticisms stem primarily from the fact that social and environmental concerns often take a back seat at the expense of economic issues (Gray, 2010) and companies are still far from a genuine commitment to sustainability (Milne and Gray, 2013). Giving priority to economic issues especially affects environmental problems such as the loss of biodiversity, because unlike carbon emissions, it is difficult to quantify it in monetary terms (Jones and Solomon, 2013).

The aim of this study is to analyse the accounting literature on biodiversity reporting and management in order to identify the issues debated by scholars and to assess the contribution of the accountants to sustainable development. To this end, the paper maps, assesses and summarises the scientific knowledge in the field of biodiversity accounting so as to come up with further insights that contribute to the development of this particular area of research. This analysis makes sense for a number of reasons. First, this paper aims to contribute to the existing literature in biodiversity accounting and management and continue to raise awareness on this specific topic. Second, although the literature on biodiversity accounting has been reviewed before (see, Cuckston, 2018; Roberts et al., 2021), this is the first study that performs a bibliometric analysis on the issue. Compared to existing reviews, which consist of a brief commentary (Cuckston, 2018) and a systematic review of the literature (Roberts et al., 2021), through a co-word analysis a complete cluster-diagram of the main research themes and sub-themes in the field is provided. The bibliometric techniques used in this study complement existing reviews as it provides a broader view of the current state of research, understanding how the existing publications are classified and related to each other. Furthermore, the analysis aims to delve deeper into the literature in order to find and discuss the critical issues arising from it. Lastly, current approaches in the field are addressed, exploring identified clusters, and potential under-researched topics are proposed. These proposals could offer a great opportunity for scholars interested in contributing and expanding current knowledge in biodiversity accounting. The study explores and categorises the literature into thematic clusters and thus future researchers could benefit from the insights derived from this analysis. This study is also important for practitioners interested in biodiversity protection, as it provides valuable information for the implementation of cleaner production practices.

The paper is structured as follows. Section 2 describes the research methodology. Section 3 presents the descriptive results and the analysis of the clusters. Section 4 analyses the state of the art of research. Section 5 discusses the main findings and explores future research opportunities. Finally, research limitations and concluding observations are reported in Section 6.

2. Methodology

The study follows a systematic literature review approach together with a bibliometric analysis, in order to identify the relevant papers and the most important themes in the field of biodiversity accounting. The combination of these two complementary methods is a common procedure in literature review publications of recent years within the area of business management and accounting (see, e.g., Bartolacci et al., 2020; Caputo et al., 2018; Kumar et al., 2019; Pizzi et al., 2020; Xu et al., 2018). While the systematic review qualitatively analyses the topics and contents of the research-field, through quantitative bibliometric tools a more objective perspective is added, as mathematical and statistical methods (i.e., scientometrics) are applied in the process (Callon et al., 1991). The design of the methodology and the steps taken are explained in the following sections.

2.1. Methodology adopted in the systematic literature review

Compared to traditional narrative reviews, the systematic review follows a rigorous, replicable method that minimises bias (Tranfield et al., 2003). This paper adopts a systematic literature review based on the three steps outlined by Tranfield et al. (2003):

- Planning the review: establishing the research question and developing a review protocol.
- Conducting a review: searching and selecting relevant papers using the inclusion and exclusion criteria.
- Reporting and dissemination: data extraction and analysis.

This approach is found in other systematic reviews (see, e.g., Boiral et al., 2018; Delbufalo, 2012; Klewitz and Hansen, 2014; Silva et al., 2019). The aim of the systematic literature review is to detect the main studies of the field of knowledge and identify the possible research gaps (Tranfield et al., 2003). To this end, key research questions were defined:

- RQ1: Which are the main peer-reviewed publications within the current literature in the field of biodiversity accounting?
- RQ2: Who are the most influential authors and journals in this field?
- RQ3: What is the intellectual structure of research in this field?
- RQ4: Which are the main research themes in this field?
- RQ5: How can the research move forward in this field?

To answer these questions a systematic review was conducted. First, during December 2020 a systematic search was performed through two different databases; a major multidisciplinary research database (Scopus) and a specific database covering the field of accounting and business management (ProQuest ABI/INFORM). For the retrieval of the documents and in order to encompass all the studies within the field of biodiversity accounting, the following search string was built and entered into the aforementioned databases: ((biodiversity NEAR/1 account*) OR (extinction NEAR/1 account*) OR (ecosystem NEAR/1 account*)) AND (disclosure OR report*). The keywords "extinction" and "ecosystem" have been considered synonymous with the term "biodiversity", given that usually both terms are included in papers about the environmental problems linked to biodiversity. The same criteria were considered with the terms "disclosure" and "report*"; "account*" was chosen to integrate both terms "accounting" or "accountability" and "report*" was selected to cover other terms (e.g., reporting). The initial search was carried out without limitations, in other words, the terms appearing in the whole document were considered, not only titles, abstracts and keywords. Adding the number of documents obtained from both databases, the initial search yielded 2,949 results (see Fig. 1).

Second, the sample was further filtered with the exclusion and inclusion criteria detailed in the following lines. In the Scopus database, the sample was limited to the subject area of "Business, Management

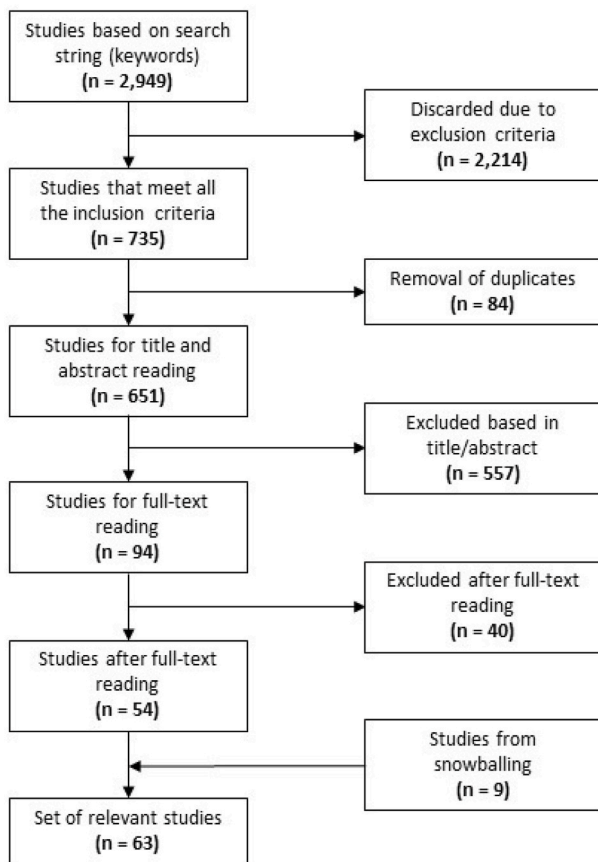


Fig. 1. Paper selection process.

The data presented was obtained from the search carried out through Scopus and ProQuest ABI/INFORM databases.

and Accounting'. This limitation was not considered for the other database, since it is a specific database for the field of business management and accounting. Only published peer-reviewed journal articles were considered; therefore books, conference papers, working papers and other unpublished work were excluded for the study. In addition, no time span limit was applied and only articles published in English were included. Using these criteria, the screening resulted in 735 articles and after removing the duplicates, 651 potentially relevant papers were identified. The titles and abstracts of all 651 papers were analysed and the authors' judgement determined those that were consistent with the research objectives (94 documents). This was followed by a thorough in-depth analysis of the full text of each of the identified articles. By reading the remaining articles, a new area of study was found; more precisely, 24 papers were identified that analysed the National Accounts and the System of Environmental Economic Accounts (SEEA) (see, e.g., Ruijs et al., 2019). SEEA is an environmental/economic statistical framework (Freeman and Groom, 2013) used to improve policy practices (United Nations, 2020a). These articles were outside the scope of this study and were therefore excluded from the final selection. The full text reading process led to a selection of a total of 54 articles that fit the scope.

Finally, the database search was complemented with snowball sampling, i.e. checking the reference list (backward snowballing) and citations (forward snowballing) of the selected papers for additional results (Wohlin, 2014). A combination of both database search and snowballing aims to achieve greater precision in identifying relevant papers that were not visible in the database search, either because they were not indexed in the databases or because the search string did not provide these results (Mourão et al., 2020). Through snowballing 9 additional papers were found. Consequently, 63 articles published from 1996 to 2020 made the cut. Each of the articles was fully read to ensure

the validity of the final selection. Fig. 1 describes the process followed for the selection of articles.

The final step for the systematic literature review is the analysis of the obtained data. For this purpose, a two-stage analysis was performed: the descriptive analysis and the thematic analysis (Tranfield et al., 2003). For the descriptive analysis, the information was categorised according to selected categories (e.g., journals covered, timeframe and geographical distribution). The thematic or content analysis was focused in the main themes and subthemes emerging from the literature and in this regard, a bibliometric analysis was conducted.

2.2. Methodology adopted in the bibliometric analysis

Although systematic literature reviews aim to minimise subjective bias (Tranfield et al., 2003), to improve the quality of the review bibliometric methods are employed, since they provide an objective quantitative rigor that counteracts the subjectivity (Zupic and Čater, 2015). The bibliometric approach is used for performance analysis and science mapping (Pizzi et al., 2020). The performance analysis evaluates the impact of research by institutions, authors or countries, whereas science mapping aims to classify and visualise the structure and evolution of scientific fields. The main bibliometric methods used in the literature are the citation analysis, co-citation analysis, bibliographic coupling, co-author analysis and co-word analysis (Zupic and Čater, 2015). This study follows a co-word analysis, which analyses the content of selected documents through the connections of keywords that co-occur in them, in order to construct a conceptual map of the biodiversity accounting and reporting discipline.

The bibliometric analysis was carried out with the use of the SciMAT software (Cobo et al., 2012). The tool allows to conduct a co-word analysis (Callon et al., 1983) to assess the themes that have attracted the most attention within the research community (Cobo et al., 2012). This specific bibliometric software was selected because, from data loading to the final visualisation of the thematic clusters, the user controls the measurements selected and the steps taken. In addition, in the pre-processing stage the tool allows the user to refine the raw data by detecting misspelled or duplicated words (Cobo et al., 2012).

A science mapping analysis of the most important keywords presented in the main documents of the research area was performed. A science mapping has the following steps: data retrieval, pre-processing, network extraction, normalisation, mapping, analysis and visualisation (Cobo et al., 2011). Once the articles had been identified and the information loaded, as mentioned above, in the pre-processing stage the initial data was refined. With the refined data a co-occurrence network is established and normalised with the equivalence index measure. The co-occurrence relationship establishes that two elements (i.e. keywords) appear together in the same document (Cobo et al., 2012). Regarding the normalisation of the network, SciMAT allows to choose between several similarity measures (e.g., jaccard index, association strength) and, as seen in similar studies, the equivalence index was chosen (see, e.g., Paule-Vianez et al., 2020; Santana and Lopez-Cabrales, 2019; Santana and Cobo, 2020).

Once the network was normalised, the simple centres algorithm clustering was used to obtain the science mapping. At the analysis and visualisation stage, the different theme-clusters are presented in a two dimensional strategic diagram (Cobo et al., 2012) based on the centrality and density network measures (Callon et al., 1991). On the one hand, centrality measures the interaction strengths between one theme and the others. On the other hand, density measures the internal strengths within a cluster (Cobo et al., 2012). The strategic diagram visually classifies the clusters into four groups (see Fig. 2):

- Motor clusters: high centrality, high density. Well-developed and important themes of the field.
- Basic and transversal clusters: high centrality, low density. Strongly connected to the rest of the themes but little developed.

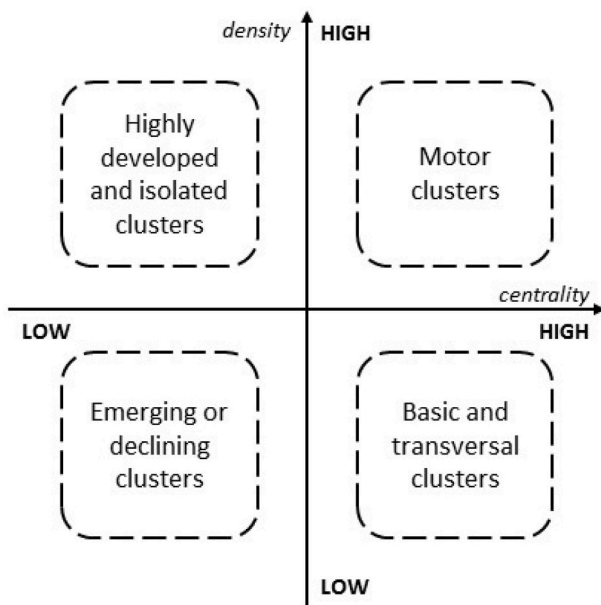


Fig. 2. Strategic diagram.

- Highly developed and isolated clusters: low centrality, high density. Specialised themes with poor connection with the rest.
- Emerging or declining clusters: low centrality, low density. Marginal and weakly developed themes.

Besides the strategic diagram, each one of the clusters has its thematic network map (Cobo et al., 2012). Due to the simple centre algorithm, each cluster is named after the central node of the thematic network map (Paule-Vianez et al., 2020) and through the cluster networks all the terms connected to that specific group are visualised. Both the strategic diagram and the thematic network maps are important not only to identify the different clusters of the research field, but also to evaluate their development within the field, observe the connections between them and foresee future research approaches.

3. Findings

Answering to the research question one (RQ1), 63 publications were identified and they are further analysed in this section. On the one hand, a descriptive analysis is carried out and on the other hand, the results obtained from the bibliometric analysis are explored.

3.1. Results of the descriptive analysis

The bibliographic data show that the biodiversity accounting field is still in its early stages (Atkins et al., 2018). Few studies were published in the late 1990s and early 2000s, highlighting the pioneering work by Jones (1996, 2003). It was not until 2010 decade that the publications increased significantly. It seems fair to say that this phenomenon is a consequence of the United Nations declaration of the “Decade of Biodiversity” for the period 2011–2020 (Adler et al., 2017) and a greater awareness on the issue. In response to Jones and Solomon’s call for more studies exploring the nature of biodiversity in an accounting context, 2013 was a pivotal year for research in the field (8 articles). Since 2017, the publications have risen significantly with 43 articles of the 63 published between 2017 and 2020; reaching the peak in the year 2018 (the result is consistent with Roberts et al. (2021)).

In addition, to answer to the research question two (RQ2), the most influential journals and authors were analysed. In this analysis, a total of 22 journals were identified (see Table 1). The *Accounting, Auditing and Accountability Journal* covers 43% of the selected articles, adopting a

Table 1
Number of articles by journal.

Journal	Publications
<i>Accounting, Auditing and Accountability Journal</i>	27
<i>Business Strategy and the Environment</i>	6
<i>Accounting Forum</i>	4
<i>Journal of Business Ethics</i>	3
<i>South African Journal of Economic and Management Sciences</i>	2
<i>Social Responsibility Journal</i>	2
<i>Conservation Biology</i>	2
<i>Sustainability Accounting, Management and Policy Journal</i>	2
<i>British Accounting Review</i>	2
Journals with only one article	13
	63

dominant role in the field. Analysing the most productive authors, three authors contributed the most with 7 published papers each of them (see Table 2). In terms of geographical distribution a wide range of countries are involved. The studies were conducted either by single countries or by collaborations between countries. The UK covers most of the studies (21 papers), followed by cross-country publications (19 papers), New Zealand (5 papers), South Africa (4 papers) and Australia (4 papers). With regard to cross-country articles, the UK, South Africa, New Zealand, Canada, Australia and Spain contributed the most.

Most of the chosen publications follow a qualitative approach, 78% of the sample. Mixed methodologies (i.e., a combination of qualitative and quantitative methods) were applied in 14% of the studies. The quantitative approach is infrequent, since only 8% of the papers apply this methodology. Regarding the theoretical approach, the analysis shows that half of the articles do not mention any theories. The rest of the publications follow either a multi-theoretical approach or a specific one. The most mentioned theories are legitimacy theory (11 papers), stakeholder theory (8 papers), institutional theory (4 papers), impression management theory (3 papers) and actor-network theory (3 papers).

3.2. Results of the cluster analysis

The research question three (RQ3) is addressed in the strategic diagram (see Fig. 3). The two dimensional diagram identifies the five main theme-clusters in the field of biodiversity accounting: one motor cluster (*sustainability*), two transversal clusters (*biodiversity reporting*, *corporate biodiversity management*) and two isolated clusters (*environmental protection*, *emancipatory accounting*). There are no emerging/declining clusters, that is, no clusters have appeared in the lower left quadrant in the analysis performed. This categorisation of thematic clusters shows at a glance the development of each one of the clusters within the field.

Sustainability is a motor cluster, highly developed in itself, that groups together the central documents of biodiversity accounting research. The subthemes of the cluster are *accounting*, *biodiversity*, *corporate social responsibility*, *sustainability reporting*, *indicators*,

Table 2
Top 10 most productive authors.

Authors	Affiliation	Publications
Cuckston, T.	University of Birmingham	7
Jones, M. J.	University of Bristol	7
Maroun, W.	University of Witwatersrand	7
Atkins, J.	University of Sheffield	6
Boiral, O.	Université Laval	6
Heras-Saizarbitoria, I.	University of the Basque Country UPV/EHU	5
Addison, P.F.E.	Buckinghamshire and Oxfordshire Wildlife Trust	4
Adler, R.	University of Otago	3
Mansi, M.	Tasmanian School of Business and Economics	3
Pandey, R.	Tasmanian School of Business and Economics	3

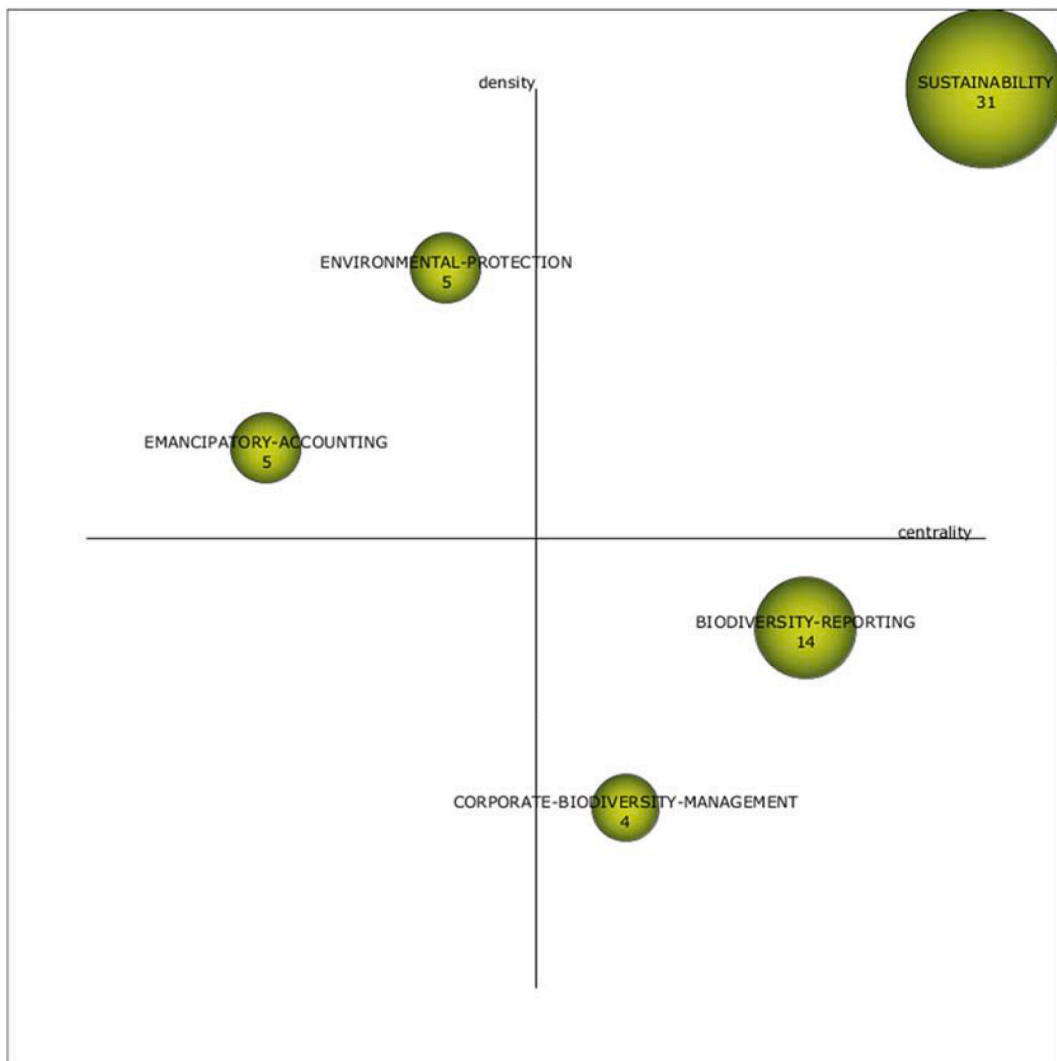


Fig. 3. Biodiversity accounting strategic diagram.

agriculture, biodiversity conservation, impact mitigation and biodiversity offsetting (see Fig. 4). These keywords are displayed as circles and the size represents the number of documents associated to that term. The circles are connected with lines and the thickness of the line is proportional to their equivalence index (Santana and Lopez-Cabrales, 2019). The documents associated to a cluster are considered core documents, which means that they are present in at least two network nodes, or secondary documents, that appear only in one node (Cobo et al., 2012). In the Sustainability theme, there are a total of 31 core documents (with 699 citations) and other 31 secondary documents (537 citations) linked to this cluster, meaning that, to a greater or lesser extent, almost all the documents have a connection with this cluster (62 out of 63). For this reason, this cluster is considered the main driver of the research field.

Biodiversity reporting is a cluster considered basic and transversal, which means that the themes within the cluster are strongly connected to the other themes, but are not fully developed. The subthemes of the cluster are content analysis, natural inventory, legitimacy, impression management, accountability and public sector (see Fig. 5). 14 core documents with 316 citations and 25 secondary documents (459 citations) correspond to this cluster.

The isolated cluster Environmental protection is a highly developed theme little related to the other themes. Five are the main documents strongly connected to this theme with the sum of 34 citations. Additionally, four secondary documents were found, with 108 citations in

total. Looking to the core documents and the number of citations, Environmental Protection is a specialised cluster, well developed in itself, but not relevant for the entire field of research. The subthemes of the cluster are development and natural resource (see Fig. 6).

The cluster Corporate biodiversity management is a transversal theme, still not fully developed but highly connected to other themes. The subthemes of the cluster are corporate environmental management and stakeholders (see Fig. 7). There are 4 core documents with 61 citations and 11 secondary documents with 163 citations addressing this theme in the literature.

The last cluster, Emancipatory accounting, is an isolated theme, which means that is highly developed but has little connection with the other themes. The subthemes of the cluster are extinction accounting and biodiversity accounting (see Fig. 8). 5 main documents (125 citations) and 11 secondary documents (203 citations) correspond to the cluster of Emancipatory accounting.

4. Literature review

Once the intellectual structure of the field is identified, to answer to the research question four (RQ4), the content of the 63 publications was analysed and the main research topics of each of the clusters were identified. This analysis further enhances the understanding of the conceptual network of the area of biodiversity accounting.

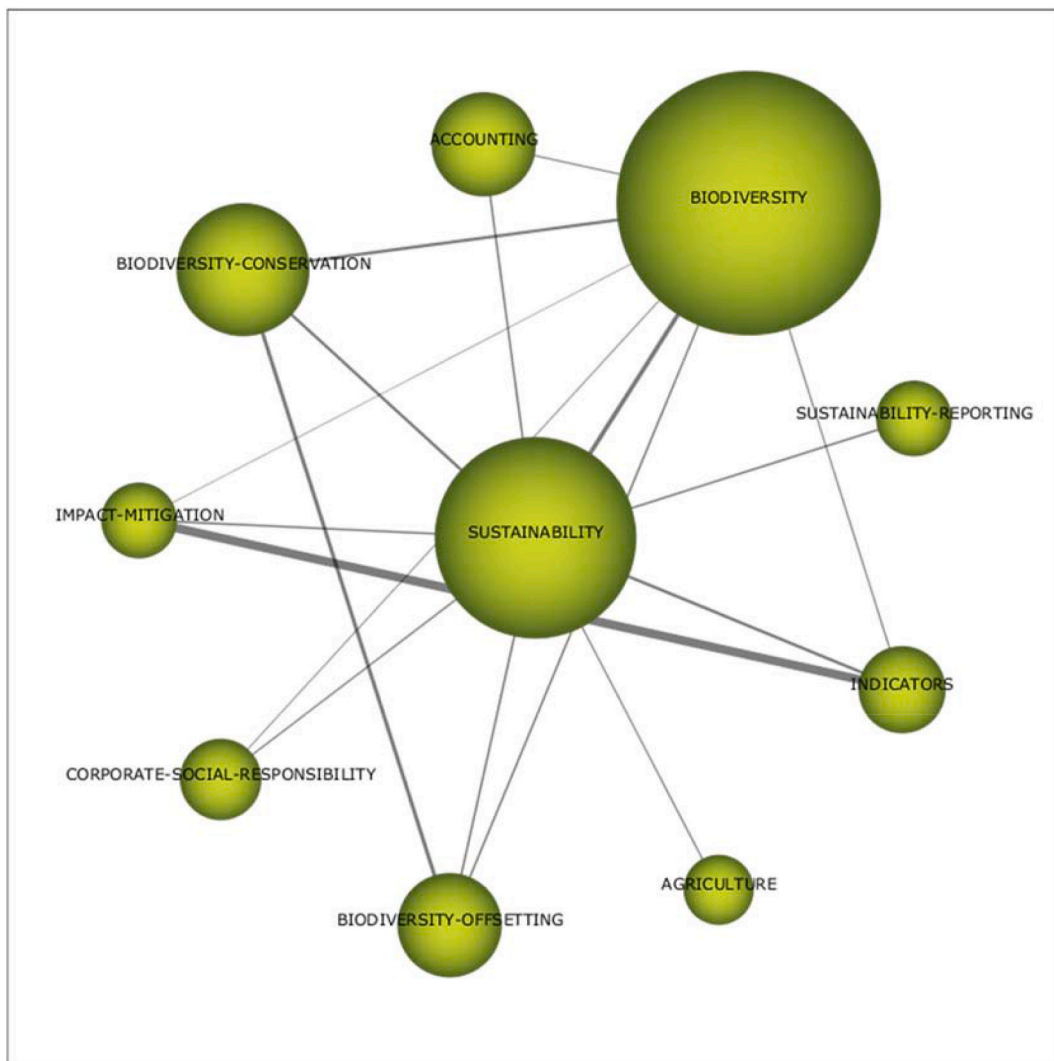


Fig. 4. Thematic network of cluster 1.

4.1. Sustainability cluster

Among the sustainability issues covered in the literature, the problem of biodiversity loss is beginning to attract the attention of the accounting research community (Feger et al., 2019). Although at first glance the connection between biodiversity and accounting appears to be non-existent or irrelevant (Atkins and Maroun, 2018), the growth of research studies on biodiversity accounting and auditing supports that accountants could also contribute to the issue. According to Jones (1996) accountants are independent and sceptical professionals with good communication skills that make them excellent participants of multidisciplinary teams, complementing their expertise with other disciplines. Traditional accounting already collaborates with experts, such as actuaries, engineers or lawyers in day-to-day work (Jones, 1996) and therefore cooperation with scientific experts in biodiversity matters could also lead to potentially successful teams. Making use of accounting information instruments, Corporate Social Responsibility (CSR) and sustainability reporting should move forward towards sustainable corporate actions, preventing extinction, protecting the environment and reducing the impacts on biodiversity (Atkins and Maroun, 2018). Accounting for biodiversity plays a crucial role when disclosing biodiversity conservation information, because it is an effective and powerful tool to spread awareness on the issue and modify behaviours in the society (Cuckston, 2018b).

Researchers have analysed the development of biodiversity conservation indicators (Houdet et al., 2012) and the adoption of such measures by corporations in order to mitigate their negative environmental impacts (Addison et al., 2019). Indicators should be simple, measurable, easy to communicate and widely applicable (Sizemore, 2015). However, studies highlight the lack of standardised indicators in the reported information, which makes it impossible to compare corporations with each other (see, e.g., Addison et al., 2019; Adler et al., 2017; Boiral et al., 2018; van Liempd and Busch, 2013). One of the main reasons that supports this idea is the complexity of the biodiversity concept itself (Addison et al., 2019). Moreover, geographical circumstances can also affect in the standardisation process. International standards may not be suitable for every local, regional and national environments (Sobkowiak et al., 2020), making it impossible to maintain uniformity, without even taking into account the problem posed by the existence of different policies in each country.

The design and implementation of biodiversity offsets also contributes to the conservation of biodiversity. The Business and Biodiversity Offsets Programme (BBOP) establishes de mitigation hierarchy (BBOP, 2013): avoid, minimise, restore and offset. Offsetting, according to the mitigation hierarchy, is the last step to achieve No Net Loss (NNL) and Net Positive Impact (NPI) of biodiversity. While biodiversity offset policies and their legal implication have been extensively covered in the literature (Ferreira, 2017), there are also research studies that cover

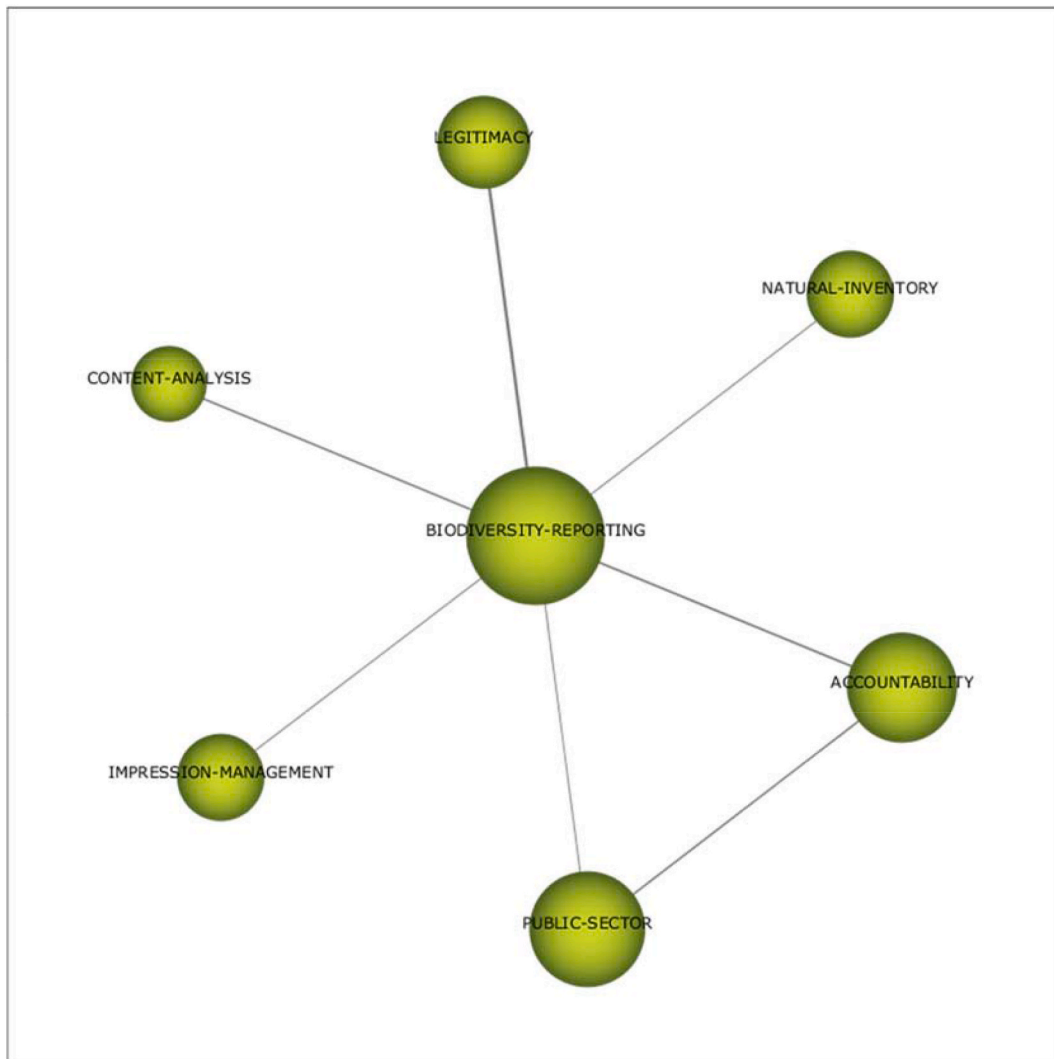


Fig. 5. Thematic network of cluster 2.

biodiversity offsetting practices by companies from an accounting perspective (see, e.g., Cuckston, 2013; Cuckston, 2019; de Silva et al., 2019; Ferreira, 2017; Taherzadeh and Howley, 2017; Tregidga, 2013), in the form of case studies and prepared interviews. Over-the-counter (OTC) carbon markets are well-known markets established to combat climate change that can also work as an important tool in conserving biodiversity. Cuckston (2013) examines the implementation of carbon offsetting in a tropical forest ecosystem scenario destroyed by slash-and-burn agriculture practices and corroborates the carbon credit trading success in protecting and developing the area. OTC carbon markets are widely recognised and unquestioned, but biodiversity offsetting market development appears to be more problematic because, unlike the carbon emissions that are possible to measure (Ferreira, 2017), the complexity of biodiversity makes it difficult to commodify and calculate (Tregidga, 2013). The commodification of nature is a controversial approach in itself and has been criticised by the scientific community (see, e.g., Cuckston, 2019; Taherzadeh and Howley, 2017). Furthermore, there is great fear that biodiversity offsetting could become a licence to trash (Ferreira, 2017). Rather than offsetting the damage to biodiversity, companies have the opportunity to buy biodiversity destruction permits and cause even more harm (Ferreira, 2017). Difficult bureaucratic procedures within the legal compliance and uncertainty in the long-term monitoring effectiveness are also barriers that biodiversity offsetting must remove for a successful implementation of

the mechanism (Taherzadeh and Howley, 2017).

4.2. Biodiversity reporting cluster

The content analysis approach of biodiversity reports is covered in many research studies (see, e.g., Ackers, 2019; Adler et al., 2020; Bhattacharya and Managi, 2013; Haque and Jones, 2020; Mansoor and Maroun, 2016; Maroun et al., 2018; Syarifuddin and Damayanti, 2019; Usher and Maroun, 2018; van Liempd and Busch, 2013) and sometimes is complemented with in-depth interviews (see, e.g., Adler et al., 2017; Adler et al., 2018; D'Amato et al., 2018; Rimmel and Jonäll, 2013).

There are few studies that analyse the reporting of specific natural species (see, e.g., Ackers, 2019; Atkins et al., 2018) and that claim the importance of this practice in order to prevent the extinction of a particular species. According to Cuckston (2018), threatened iconic animals evoke an emotional response and corporations are more willing to get involved with the cause and raise funds to protect them. Furthermore, the extinction of species is no longer an abstract concept, since there is a specific species that must be preserved (Cuckston, 2018b). Despite support for specific species reporting, some argue whether focusing on one species is the best approach or not, as it may lose the sense of protecting biodiversity as a whole (Gray and Milne, 2018). Certain species attract more attention than others that remain invisible (Weir, 2019). Mammals or birds, for example, are considered

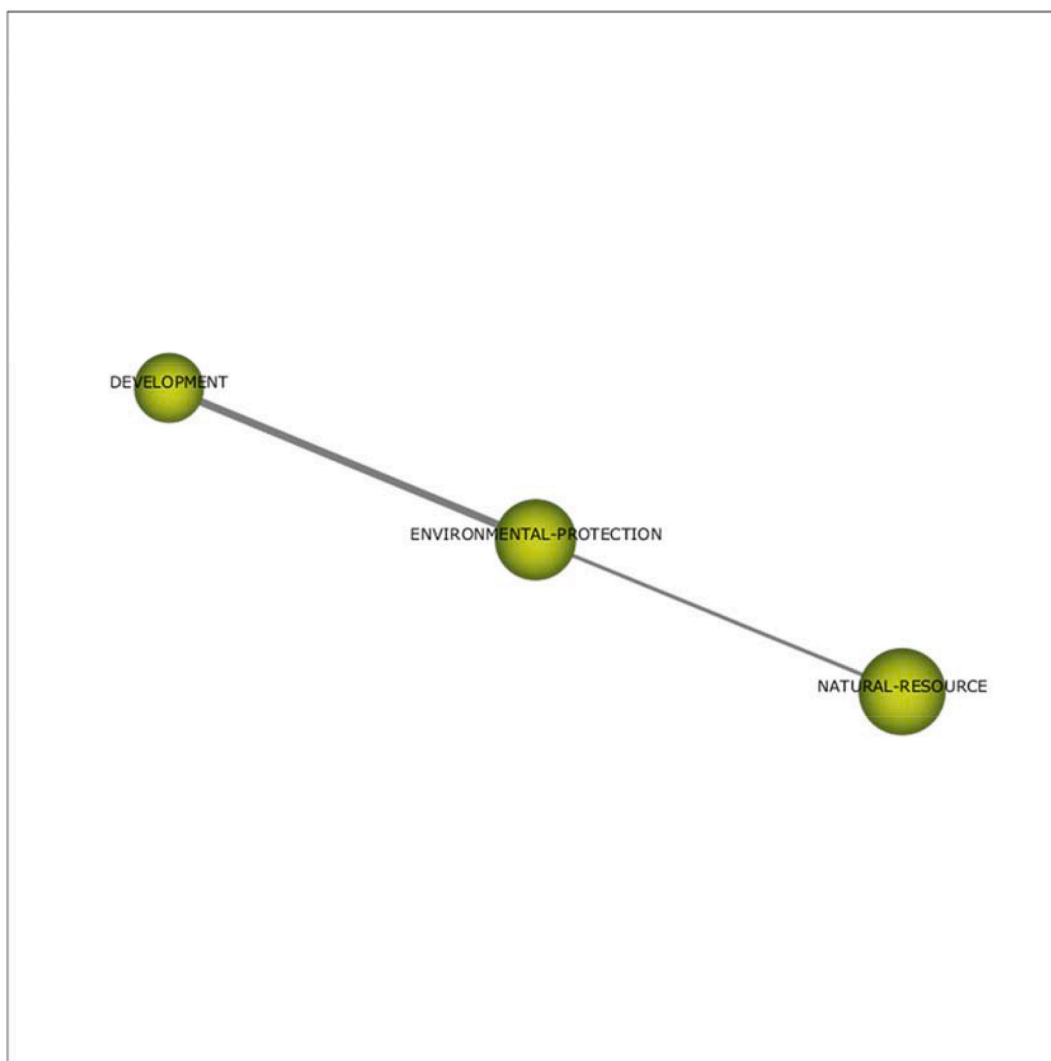


Fig. 6. Thematic network of cluster 3.

more appealing species comparing to insects (Atkins and Maroun, 2018), but they are equally important and interconnected in the ecosystem (WWF, 2020). In fact, the complexity of biodiversity is such that there are still thousands of animal and plant species that remain to be discovered and the effects of their loss are unknown (WWF, 2020).

When talking about biodiversity accounting, there are two perspectives: the anthropocentric and non-anthropocentric view. Both coexist and contribute to the current literature (Atkins et al., 2018) and the main difference lies in the ethical approach. The anthropocentric perspective advocates that biodiversity should be protected for human benefit. In a direct way, the loss of species implies a reduction of essential resources (e.g., food, materials etc.) for humankind; but indirectly it also has unprofitable outcomes, because it affects pollination, food production and climate stabilisation (Jones and Solomon, 2013). The non-anthropocentric perspective, also known as deep ecology (Naess, 1973), raises awareness about the intrinsic value of biodiversity. All living beings are equally important and their intrinsic value is incalculable and irreplaceable by itself (Maunder and Burritt, 1991). Although the initial research was carried out around an anthropocentric perspective, awareness of the intrinsic value of nature is emerging in the literature (see, e.g., Samkin et al., 2014).

In addition to in-depth reporting analysis, some studies attempted to implement Jones' natural inventory model (Jones, 1996) and assess its feasibility. Jones (1996) proposes three stages of the model: the

establishment of six levels of natural inventory, the assessment of non-critical habitats and the summarised dissemination of the results. The natural inventory could be integrated into environmental reports or work as a complementary source (Jones, 1996). As the application of the natural inventory depends on the available data (Siddiqui, 2013), although some studies cannot test all levels of the inventory (see, e.g., Jones, 2003), researchers agree on the feasibility and potentiality of the tool (see, e.g., Horner and Davidson, 2020; Hossain, 2017; Siddiqui, 2013).

Studies agree that improving social legitimacy is the main incentive for companies to voluntarily report on biodiversity issues. In order to improve, maintain or repair legitimacy, compared to more substantial alternatives, impression management is the easy option chosen by several companies (Boiral, 2016). Some environmental reporting practices use selective information (Hrasky and Jones, 2016), strategic greenwashing techniques and self-praise statements that are far from a true will to conserve biodiversity (Adler et al., 2017). This lack of genuine commitment implies a tendency for corporations to report the positive aspects more than the negative ones (Hassan et al., 2020), thus projecting an idealised picture towards stakeholders (Boiral, 2016). Boiral (2016) mentions four impression management neutralisation-techniques that companies use when reporting: statements of net positive or neutral impacts on biodiversity, negations of serious impacts, distancing behaviour from impacts and dilution of

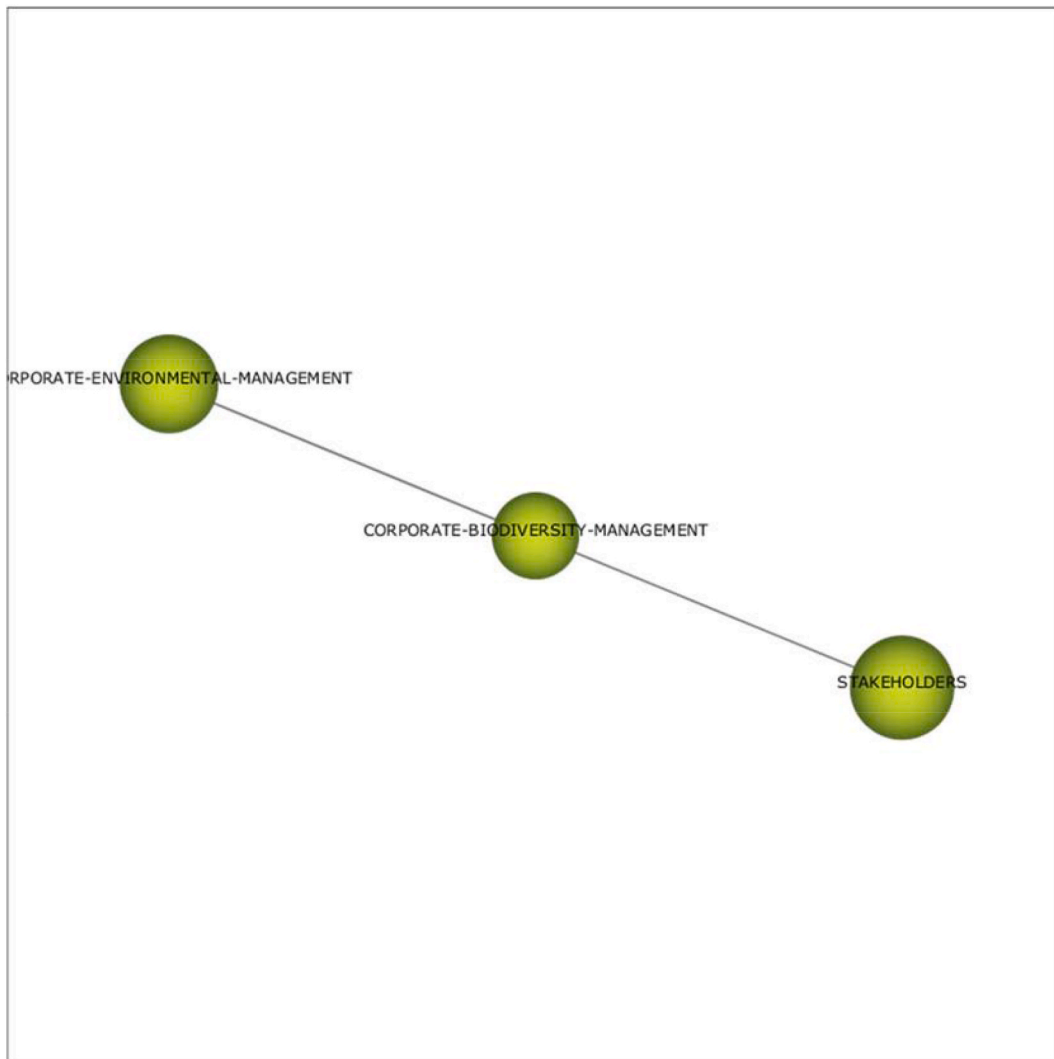


Fig. 7. Thematic network of cluster 4.

accountability. Most polluter companies (i.e., red-zone firms), which are therefore under more pressure from public scrutiny (Hassan et al., 2020), are more likely to use impression management tools (Adler et al., 2018). While it is true that negative information may affect the reputation of the company (Hrasky and Jones, 2016), the use of impression management techniques can lead to unexpected results, increasing social scepticism (Boiral, 2016), reinforcing critical views towards the corporation (Adler et al., 2017) and undermining its credibility (Boiral, 2016).

Although most of the studies analyse the corporate reporting practices, public sector disclosure has also attracted the attention of academics. Reporting on biodiversity conservation is essential to achieve transparency and accountability towards society (Gamborg, 2002) and the many heterogeneous stakeholders with whom they interact (Gaia and Jones, 2017). Public authorities often do not have to comply with mandatory legal requirements to report on sustainability (Schneider et al., 2014), but as they manage large public areas containing natural assets, they are accountable for their community and therefore, they have a duty to serve (Gaia and Jones, 2019). Stakeholders have the right to be aware of the actions taken to conserve biodiversity and the progress that is being made (Gaia and Jones, 2019), as well as the right to know and evaluate how public expenditure is managed (Schneider et al., 2014). Furthermore, accountability for government agents is significantly more important than for private companies because citizens elect

them and the demands for transparency are greater (Gaia and Jones, 2019). However, the reported public information, when available, appears to be limited (Barut et al., 2016) and not adequately disclosed (Khan, 2014). The main reasons for this could be that public authorities use the reporting tools for impression and legitimacy purposes rather than for transparency motivations (Gaia and Jones, 2019) or that this kind of reporting is considered a low priority (Weir, 2019). Budget constraints of public money that prioritise other political actions and the fact that in some cases it is still believed that the impacts on biodiversity are not induced by human activities (Weir, 2019) are also factors that influence in the weak response towards the disclosure of biodiversity conservation.

4.3. Environmental protection cluster

During the last decade, the protection of the environment has been one of the main concerns of the accounting community; in particular, issues such as the emission of greenhouse gases have been widely covered (Jones and Solomon, 2013). Researchers agree that accountants should join forces with conservation scientists (Feger et al., 2019) and thus begin to engage in interdisciplinary work projects (Cuckston, 2017), building synergic relationships.

International environmental targets have been developed to take action against the biodiversity loss problem, such as the Aichi Targets of

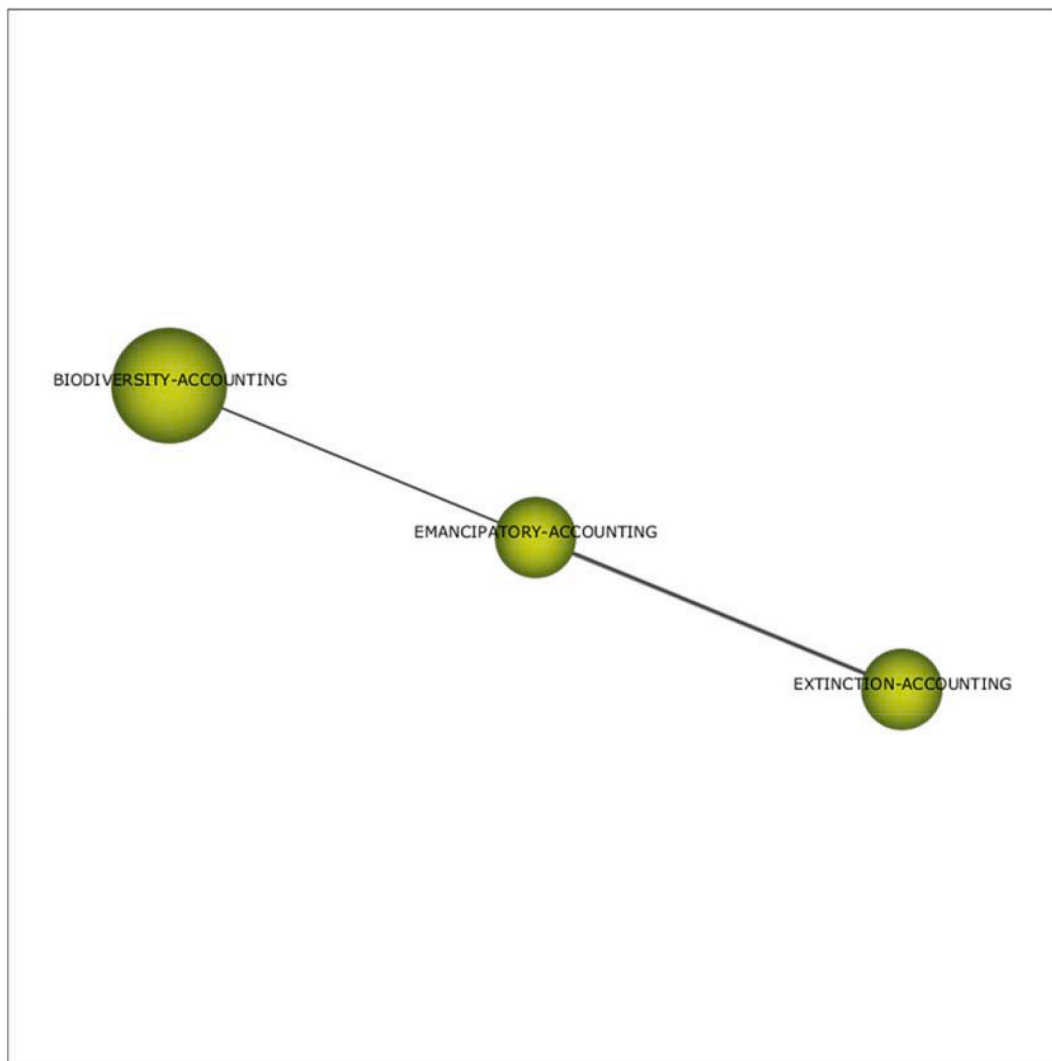


Fig. 8. Thematic network of cluster 5.

the Convention on Biological Diversity (CBD) (CBD., 2011) and the Sustainable Development Goals (SDG) (United Nations, 2020b), specifically SDG 14 and SDG 15. Although companies are addressing sustainable goals in their corporate commitments to combat biodiversity loss (Addison et al., 2019), measures to mitigate the impacts of their activities are still in the development stage (de Silva et al., 2019). One of the reasons for the lack of adequate participation by corporations could be that, above all, the sustainable development challenges fall on the governments of each country (Sobkowiak et al., 2020). Addressing biodiversity performance and contribution to the SDGs not only by governments (see, e.g., Sobkowiak et al., 2020) but also by companies is essential to work towards sustainable development.

4.4. Corporate biodiversity management cluster

Several researchers have analysed the corporate management practices in terms of biodiversity protection. According to them, environmental accounting practices often focus on reporting companies' performance to gain social legitimacy, rather than on the implementation of internal managerial actions (Boiral et al., 2019) and the information disclosed rarely provides details on the implementation of these organisational activities (Bhattacharya and Managi, 2013). More concerned with external perceptions (Boiral et al., 2019), companies fail to adopt a proper internal approach, leaving the implementation of

biodiversity practices in mere symbolic and superficial actions (Boiral et al., 2018a,b). The motivations of the corporations should not be driven only by financial or reputational reasons (Bhattacharya and Managi, 2013), but by the social and environmental implications that the problem of biodiversity loss entails.

Researchers also believe that companies must adopt internal day-to-day activities to reduce biodiversity impacts (Boiral et al., 2019) with adequate assessment tools (Bhattacharya and Managi, 2013). With clear goals and commitments for biodiversity management (Boiral et al., 2019), an internal plan for decision-making should be developed (Addison et al., 2020). Companies must take an active role in the implementation of structured biodiversity management frameworks that allow them not only to achieve their objectives, but also to minimise the environmental impacts derived from their operations (Addison et al., 2020).

Some studies further explore stakeholder engagement in biodiversity management practices. Researchers agree that biodiversity loss is a complex issue to address and, without the appropriate knowledge, is difficult to implement effective biodiversity management practices. This means that organisations are not intended to tackle this task alone and partnerships with stakeholders would provide beneficial outcomes that independently are unthinkable to achieve (Boiral and Heras-Saizarbitoria, 2017b). Stakeholder engagement would not only improve corporate social legitimacy but would also help to improve

internal procedures, knowledge management and skill learning in the company (Boiral and Heras-Saizarbitoria, 2017a). This relationship contemplates a clear willingness to protect the biodiversity in exchange for the exploitation of natural resources by companies, while improving social acceptability (Boiral and Heras-Saizarbitoria, 2017a). Stakeholders include a wide range of agents, such as company employees. Managers are often in a distant position from field operations (Boiral et al., 2018a,b) and employees have developed greater knowledge of the direct impacts that corporations' operations have on biodiversity, due to their job position, their previous experiences and their personal training and interests (Boiral et al., 2019). Employee training and internal communications are fundamental in order to implement and internalise biodiversity protection practices (Boiral et al., 2018a,b). Local indigenous communities are also aware of the impacts of companies on biodiversity because their life is closely connected to nature and it is necessary to include these stakeholders in the business management project (Boiral and Heras-Saizarbitoria, 2017b).

4.5. Emancipatory accounting cluster

Although the concept of biodiversity is difficult for companies to understand and disclose (Jones and Solomon, 2013), researchers agree that accounting practices have emancipatory potential (Atkins et al., 2018). Traditional accounting is a merely calculative tool that fails to communicate the problem of biodiversity loss, trying to measure it only in financial terms (Jones and Solomon, 2013). New forms of accounting and accountability must be constructed that go beyond reputational and legitimacy concerns and genuinely seek successful sustainability reforms (Russell et al., 2017). Accounting for biodiversity enhances the protection of biodiversity by sensitizing business stakeholders and reporting on management practices in an attempt to mitigate companies' impact (Jones and Solomon, 2013).

Russell et al. (2017) encourage new forms of ecological accounting to improve biodiversity management, and extinction accounting is an ideal example of this kind of approach. Atkins and Maroun (2018) go beyond biodiversity accounting and reporting by defining the concept of extinction accounting, a tool to prevent extinction. Extinction accounting evolves from biodiversity accounting because it is not understood merely as a disclosure instrument (Atkins and Maroun, 2018). Companies must acknowledge the importance of biodiversity loss prevention not only focusing on the monetary implications but also accepting its social and environmental impact. Both anthropocentric and deep ecology perspectives combine in the extinction accounting, because there is a genuine concern of the extinction problem and seek to stop the negative impacts of it, encouraging positive change (Atkins and Maroun, 2018). Atkins and Maroun (2018) have developed the extinction accounting framework to disclose on extinction prevention identifying seven stages of reporting. The framework has been applied in other research studies (see, e.g., Atkins and Maroun, 2020; Maroun and Atkins, 2018; Weir, 2018).

5. Discussion and future research directions

Biodiversity accounting is an emerging field among business, accounting and management research studies. In this study, through a bibliometric analysis of 63 papers, five main different thematic groups within the current literature are found. After examining the conceptual structure of the field and the impact of each cluster, the study attempts to foresee the future development of the area, giving answers to the research question five (RQ5) and, accordingly, potential avenues of research are proposed. In this section the opportunities presented by each of the clusters are analysed, as well as the research gaps and critical issues detected in current knowledge.

The *Sustainability* cluster reveals that the preservation of biodiversity does not only fall to the scientific community. Accountants play an important role in biodiversity conservation practices (Feger and

Mermet, 2017), because they are in charge of communicating companies' actions towards environmental sustainability (Jones and Solomon, 2013). While the importance of the accountant is fully recognised, the role of the auditor remains unexplored in the literature. Equally important is the corporate communication of biodiversity initiatives through reports, as well as the required assurance of the information provided by external auditors. Non-financial information should be audited to provide the truthfulness of disclosures on environmental issues, such as biodiversity loss, and the actions the company takes in this regard. It is not only a matter of whether there is a material risk or not, but of evaluating that the information is reliable and, unfortunately, the assurance usually provided is not sufficient or does not exist (Ackers, 2019). Currently, instead of external audits, NGOs play an active role in the assurance and verification of organisational practices on the environment (Usher and Maroun, 2018) and in fact, they are perceived as a reliable organisation comparing to other agents (Boiral et al., 2018a,b). Stakeholders trust more in those companies with reports where high assurance levels are guaranteed (Hassan et al., 2020) and, although it is very difficult to verify the information related to an issue as complex as biodiversity (Boiral and Heras-Saizarbitoria, 2017b), progress in auditing practices is critical to increase corporations' reliability. Biodiversity auditing/assurance is a promising research topic that has not been fully developed in the literature and researchers should further explore it.

Another research opportunity presented in the first cluster is related to current biodiversity indicators. The standardisation of biodiversity indicators that are easily measured and communicated is essential for comparison and evaluation, but there are still doubts as to whether these indicators should be international or not. When referring to biodiversity reporting, some studies agree that it may be a better approach to disclose information taking into account the national or even local environment in which organisations are located rather than disclosing in a global context (see, e.g., Raar et al., 2020; Smith et al., 2019; Weir, 2018). Although biodiversity conservation is a global concern, the actions to be taken from one region to another are different, as ecosystems also differ substantially. In this sense, international indicators, such as the Global Reporting Initiative (GRI) standards, may be inadequate or insufficient for specific biodiversity environments (Sobkowiak et al., 2020). Sobkowiak et al. (2020) propose a bottom-up approach to rely on rather than the usual top-down standards, stating that these indicators would reflect more appropriately the specific circumstances, such as the actions taken by companies on biodiversity and the overall performance in a particular area. In addition, analysis of the impact of the Eco-Management and Audit Scheme (EMAS) or ISO 14001 certifiable standards on biodiversity conservation could provide different perspectives on the issue. Further research focused on biodiversity indicators could seek answers to these queries.

The bottom-up approach could also be applied in biodiversity offsetting, as these offset markets are geographically limited. Biodiversity offsetting is a topic covered by many papers, but the evolution of this kind of offset markets still presents potential research opportunities to work with. Even though some of the biodiversity offset pilots analysed in the literature failed in implementation (see, e.g., Ferreira, 2017; Taherzadeh and Howley, 2017), more research is needed to draw argued conclusions about their applicability. Future studies could research about the implementation of biodiversity offsetting in different locations and evaluate its applicability for different biodiversity scenarios.

Overall, biodiversity reporting analyses constitute the main research work in biodiversity accounting literature, as seen in the *Biodiversity reporting* cluster. Furthermore, most studies focus on content analysis of these corporate reports and sometimes they incorporate the perceptions of selected interviewees. There are few studies that go beyond mere qualitative research on corporate biodiversity management and disclosure (see, e.g., Freeman and Groom, 2013; Haque and Jones, 2020; Husin et al., 2018; Krause et al., 2020), and although qualitative studies should be interesting, there is a great need for more robust empirical quantitative papers within the area of biodiversity accounting. This

conclusion is also addressed in the review conducted by Roberts et al. (2021). Therefore, an increase in quantitative studies could benefit the development of the field.

Additionally, in the current literature there are not only studies analysing corporate reporting but also the disclosure of public authorities. However, other types of organisations with an important weight in the development of biodiversity conservation are not being sufficiently analysed in the literature. There is a lack of studies focusing on NGOs or co-operatives (see, e.g., Horner and Davidson, 2020; Lanka et al., 2017) and further research into these organisations can positively contribute to biodiversity accounting knowledge.

In terms of theoretical perspectives applied in the literature, when analysing biodiversity-related information in corporate reports, the main theories applied are the legitimacy theory (Deegan, 2002) and the stakeholder theory (Freeman and Reed, 1983). Voluntary environmental disclosure is the result of organisations seeking to be legitimate towards their stakeholders, but this reputational motivation can lead to the use of not-so-genuine techniques (Adler et al., 2017), making use of impression management. The impact of reporting practices goes beyond the idea that companies are accountable to their stakeholders. The great potential of sustainability reports is the fact that organisations can switch the way people think and their attitude towards environment and biodiversity. Studies must shift from an anthropocentric perspective to an eco-centric one, trying to analyse reporting practices with a deep-ecology approach (see, e.g. Samkin et al., 2014). Recognising the intrinsic value of all species and protecting all of them regardless of their human use should be the main incentive of organisations when it comes to disseminating biodiversity reports and, thus, researchers should consider the non-anthropocentric view in their studies approach.

Exploring the research related to *Environmental protection* cluster, the literature suggests that in recent years environmental protection has risen positions within the priorities of corporations, but the issue of biodiversity conservation in particular has not yet reached the importance it should have. This could be due to the fact that the biodiversity loss issue is diluted with other environmental concerns, without addressing it individually. An appropriate way to carry out biodiversity conservation initiatives is to align them with sustainable development commitments, such as the SDGs. Sobkowiak et al. (2020) explored the UK government's annual biodiversity report and their contribution to SDG 15. It is the only study focusing on SDGs within the current literature on biodiversity accounting. Similar research using other national governments as a reference is more than welcome and research in a corporate context to see how companies contribute to the SDG 14 and SDG 15 could also extend the body of knowledge.

In the *Corporate biodiversity management* cluster, researchers raised the importance of managerial implication in the biodiversity issue. In addition to disclosing external environmental reports, companies must take a proactive role by implementing cleaner production technologies to protect and conserve biodiversity internally. With an internal planning and adequate strategical objectives (Addison et al., 2020), corporations must minimise their impacts on biodiversity moving towards a zero-harm scenario. The results may not be seen in the long term, but from day one companies must adopt this behaviour in their daily activities (Bhattacharya and Managi, 2013), from field-operators to managers. While biodiversity reporting is the primary focus of research for most studies, few pay attention to the internal face of the company. Biodiversity conservation actions should be taken both internally and externally and, therefore, further research in the area of corporate biodiversity management is welcome.

Another potential area of research could be the stakeholders' involvement in the corporate activities, so as to protect and conserve nature. Boiral et al. (2019) examine employee engagement in corporate biodiversity management practices and consider that their involvement is beneficial for the protection of biodiversity. Some studies also remark the importance of indigenous communities in corporate decision processes (see, e.g., Boiral and Heras-Saizarbitoria, 2017b; Cuckston,

2018a; Samkin et al., 2014). Indigenous people are strongly connected to nature both physically and spiritually (Cuckston, 2018a). While the western perspective fails to understand the complexity of ecosystems (Gray and Milne, 2018), indigenous communities have first-hand knowledge (Cuckston, 2018a), as they depend on the natural resources where they live (Boiral and Heras-Saizarbitoria, 2017a). Companies must realise that their operations and impacts on biodiversity directly affect indigenous people and therefore cooperation with local communities in biodiversity management activities is essential.

The last cluster, *Emancipatory accounting*, proposes new forms of accounting practices. As traditional accounting does not adequately report biodiversity loss, mainly because it is difficult or even impossible to calculate it in monetary terms (Jones and Solomon, 2013), there is potential in other accounting frameworks. The extinction accounting framework proposed by Atkins and Maroun (2018) and the natural inventory by Jones (1996) are excellent examples of non-traditional accounting practices that companies could implement in order to inform about biodiversity. Biodiversity is a complex issue in itself, difficult to address with mere financial calculations. Accounting practices should go beyond the established boundaries and therefore, future research work on emancipatory biodiversity accounting and its implementation in different organisational settings is more than welcome.

6. Conclusion

This study examines and shows the intellectual structure of the field of biodiversity accounting and management. A systematic review of current knowledge is carried out, complemented with bibliometric methods, in order to obtain a conceptual map of the field. Through a co-word analysis of the most important keywords included in 63 selected publications, the current scientific production of biodiversity accounting is structured into five differentiated thematic clusters: *sustainability*, as a motor theme; *biodiversity reporting* and *corporate biodiversity management*, as transversal themes; *environmental protection* and *emancipatory accounting*, as isolated themes. In addition, the content of the emerged themes has been analysed and consequently several directions for further research are suggested.

The field of biodiversity accounting and management shows great opportunities for the development of the area. Few are the studies that pay attention to the auditing/assurance of biodiversity information in environmental reports. More research on auditing practices by external professionals or NGOs could indeed benefit the biodiversity accounting field. Other potential topics of study are the research on the standardisation of biodiversity indicators and the possibility of adoption of bottom-up approaches, as well as the offsetting practice in different biodiversity scenarios. Most studies focus primarily in the qualitative analyses of the biodiversity reports and there is a lack of more robust quantitative analyses. The content-analysis of non-financial reports through a deep-ecology lens is still needed, but these should also include non-governmental and non-corporate organisations. Additionally, research on SDG 14 and 15, corporate biodiversity management practices, stakeholder engagement and new forms of emancipatory accounting are promising areas that future researchers should consider.

This work provides three main contributions to the research field of biodiversity accounting. First, the study contributes to this emergent field and its further development. The analysis carried out in this study pointed out an increase in academic studies published in recent years and based on this growth, it is fair to say that the area of biodiversity accounting has a promising research future. The second contribution of the study is the bibliometric analysis carried out. These bibliometric techniques have provided not only a better understanding of the current state of the literature, but also of the critical issues that exist in the field. Finally, as a third contribution, the potential research topics proposed could allow the research to progress, either because these topics are not yet fully developed or because they would cover the gaps found in the existing literature.

The study has several implications for scholars, policy makers and practitioners. The results provided in this analysis could assist policy makers in biodiversity regulation decision-making, for example by incorporating these insights in the European Financial Reporting Advisory Group's (EFRAG) sustainability reporting framework. The involvement of management and accounting scholars with international organisations and academics researching the Global Biodiversity Framework and the SEEA framework in transdisciplinary projects could also lead to new perspectives in the development of biodiversity conservation guidelines (United Nations, 2020a). The study provides also new insights for practitioners who may find them useful for biodiversity management decisions. The alignment of scholars and practitioners towards better biodiversity conservation practices could greatly benefit both parties.

This research has some limitations. The analysis solely focuses in published research papers obtained from two databases. Adding more databases and other types of research work (e.g., books, conference papers) could lead to different results. In addition, the final selection of the articles is based on authors' judgement and, although bibliometric techniques have been used, there is certainly some degree of subjectivity involved. Another limitation of this study is that biodiversity accounting is an emerging field and the number of publications in this regard is limited. However, based on the growth of publications in recent years, this limitation is an indicator of the potential of the field and, thus, an increase in future studies is expected. This study only considers literature on business studies and therefore future work could extend the analysis to other research areas, thus following a transdisciplinary approach. As a final limitation of the study, the issues arising from the use of keywords in co-word analyses must be highlighted. On the one hand, it may happen that journals do not include keywords in their bibliographic data and, on the other hand, the keywords could be affected from the indexer effect (Zupic and Cater, 2015). This problem has been solved by refining the data, including the keywords that were missing and adding other terms that authors thought were appropriate after fully reading all the documents. Research in the field is much needed and in this regard, the topics proposed should inspire researchers interested in biodiversity protection, cleaner production and sustainability to further contribute to the literature.

CRedit authorship contribution statement

Goizeder Blanco-Zaitegi: Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing. **Igor Álvarez Etxeberria:** Conceptualization, Writing – original draft, Writing – review & editing. **José M. Moneva:** Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors are unable or have chosen not to specify which data has been used.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jclepro.2022.133677>.

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