



## Research article

## Responsible sourcing for energy transitions: Discussing academic narratives of responsible sourcing through the lens of natural resources justice

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## ABSTRACT

The Paris Agreement and the United Nations' Sustainable Development Goals clearly demonstrate the need for global energy transitions. Evolving energy generation and the expansion of the renewable energy capacity and associated infrastructure contribute to changing and increasing demands for minerals and metals. The potential negative environmental, social and economic impacts of increased mineral resource production have been contested and are under increasing scrutiny by both academia and civil society. Responsible Sourcing (RS) has become a management approach for companies and policymakers to identify, monitor and address potential negative impacts along their raw materials' supply chains. Although RS might contribute to sustainability along the supply chain, this paper raises the question of whether it also contributes to Natural Resource Justice (NRJ) in energy transitions. Based on a bibliometric network analysis, this study investigated current narratives of RS literature and to what degree core aspects of NRJ (e.g., distribution of benefits and burdens, power asymmetries, property rights) are reflected in the RS debate following a deductive approach. The results obtained show that compared with other sectors (e.g., timber, food, biomass, textiles) debates on RS in renewable energy-related sectors are still scarce and fragmented. The analysis indicates that different foci are aligned with one or more of the traditional three sustainability dimensions (i.e., environmental, social, economic), while few addressed aspects of NRJ. The authors observed a distinct lack of holistic justice considerations in the current RS debate and only a few individual issues are discussed, such as the detection of burden shifting, accountability for supplier behavior, and sharing of financial benefits. This research contributes to the understanding of different RS approaches and extends the RS discussion to NRJ considerations in energy transitions. It also points out important paths for future research to contribute to just energy transitions.

## 1. Introduction

Historically, energy transitions, i.e. the transition from one energy system to another, occurred repeatedly. Such transitions not only cause changes in energy generation, distribution, storage, and usage, but also drive societal changes including production methods and productivity as well as livability (García-García et al., 2020; Lee and Yang, 2019). While past energy transitions were mostly involuntary, the current transition from fossil fuels to renewable energy sources is a complex policy-led process with time goals (García-García et al., 2020). Since this transition has become a prerequisite to addressing the global challenges of climate change and environmental degradation this paper will focus

on renewable energy sources. As part of the broader transformation toward more sustainable societies, the transition to renewable energy is also required to advance toward the United Nations' Sustainable Development Goals (SDGs) and to meet the Paris Agreement's 1.5 °C target (Bogdanov et al., 2021; Mazzucato, 2020). This development is further accelerated by geopolitical aspects such as the recent war in Ukraine and the related energy supply risk in Europe, urging countries to seek energy security and looking to phase out fossil fuels at the same time (Palle, 2021; Žuk and Žuk, 2022). The urgency of identifying and implementing transformation pathways, with all the associated difficulties, is also being discussed in various IPCC reports (e.g., IPCC, 2022a, 2022b, 2018). An increasing number of both - policies and research -

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emphasize the importance of ethical and just approaches to energy transitions as well as sufficient consideration of vulnerable communities and groups (Byskov et al., 2021; Gillard et al., 2016; IPCC, 2022a; Vatalis et al., 2022). ‘Justice’ requires particular attention given the changing demand for raw materials (from fossil fuels and carbon to minerals and metals) used for energy generation, storage, and transmission as countries are pursuing the decarbonization of energy systems and society at large (Carley and Konisky, 2020; Wang et al., 2020). Previous research on environmental and climate governance, emphasizes that justice (e.g., distributional, procedural, and social) must be considered ‘from the start’ of the problem definition and not only when designing mitigation or adaptation strategies (Anguelovski et al., 2016; Eriksen et al., 2021; IPCC, 2022a). Without adequate consideration, the transition to low-carbon energy technologies will not lead to more sustainable societies, but rather “produce and, in many cases, perpetuate pre-existing sets of winners and losers” (Carley and Konisky, 2020, p. 569). While the winners benefit from energy transitions and clean energy generation, the losers bear the consequences and burdens of these sustainability transformations, in particular of the related resource extraction and associated environmental pollution and degradation, societal, social and cultural impacts, armed conflict, and land-grabbing, and/or loss of livelihoods (Carley and Konisky, 2020; Kojola, 2019; Lèbre et al., 2020).

To tackle these challenges and strive for a just (re-)distribution of access to and benefits of natural resources, advances in global resource governance (Ali et al., 2017) and earth stewardship (Chapin et al., 2022) are needed. These concepts play a progressively important role in transition research (e.g., Christmann, 2021; Watari et al., 2021) which draw substantial attention to aspects like natural resource justice (NRJ). Accepting the finiteness of natural resources and the constraints on how these resources can be used, NRJ conceptualizes (i) the distribution of resource rights; (ii) the distribution of benefits and burdens derived from resource use; (iii) the distribution of decision-making power regarding resource use, and (iv) the potential use and protection of resources (Armstrong, 2017). Debates on NRJ also address direct and indirect green extractivism (Dunlap and Marin, 2022; Jerez et al., 2021); and neo-, green-, or resource colonialism (Hilson et al., 2019; Normann, 2021). Social, ecological and climate impacts of low-carbon infrastructure (i.e., deforestation, habitat loss and fragmentation, competition with agricultural land, etc.) and securing minerals and metals for low-carbon technologies (land enclosure and privatization of common resources) are in the focus of discourses on green extractivism (Dunlap and Jakobsen, 2020; Dunlap and Marin, 2022; Jerez et al., 2021). Whereas debates on neo-, resource-, and green colonialism emphasize colonial practices related to mineral resource extraction (Hilson et al., 2019; Parson and Ray, 2018), including grabbing and loss of land and rights due to renewable energy developments (Normann, 2021) paralleling historic colonial processes of dispossession and oppression. While land, soil, water, air, minerals, and metals are crucial for human development and well-being, the livelihoods and cultures of indigenous communities and rural populations particularly depend on different natural resources (Mishra et al., 2021; Natcher and Brunet, 2020; Sweetman and Ezpeleta, 2017). To ensure not only just access to natural resources including mineral resources, but also that their benefits and associated risks are shared in a just manner, requires thoughtful and anticipatory management and governance. Despite the detrimental impacts as well as environmental and social challenges of intensified mineral resource extraction for low-carbon technologies, ‘justice’ is largely overlooked or even ignored in the debates on mineral resource extraction and the extractive sector (Heffron, 2020; Kügerl et al., 2022). As a response, Heffron (2020) suggested the ‘JUST framework’: it includes three different elements of Justice (distributive, procedural, recognition), two forms of Universal justice (cosmopolitanism and restorative), Space considerations (the location of extraction projects and national and international links and influences), and the Time, i.e., the speed of transitions or timelines for goals such as the Paris

Agreement. Attaining a just distribution of mineral resources and their associated benefits, all items of the JUST-concept must be adequately addressed on local, national, and international levels. The successful prevention of negative environmental and social impacts as well as burden shifting in global mineral supply chains requires the commitment and cooperation of all involved actors at all levels. Compared to neighboring academic discourses such as environmental and climate sciences (e.g., Lukasiewicz et al., 2017; Roy and Schaffartzik, 2021; Sowman and Wynberg, 2014), there seems to be a distinct lack of NRJ in the literature on the extractive sector and mineral supply chains. Scholarly works have mainly focused on justice-aspects associated with specific extractive operations, such as environmental justice, extractive violence, and territorial aspects in indigenous contexts (Hope, 2022; Nachet et al., 2021), procedural and distributive justice (Witt et al., 2018), or the mapping of ecological distribution conflicts (Martinez-Alier, 2021). However, the discourse fails to address the entirety of NRJ and the potential influence of downstream supply chain actors on justice in extractive operations posing a research gap.

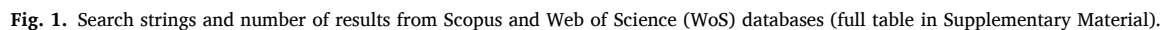
One approach to address the challenges and adverse impacts in global supply chains is responsible sourcing (RS), which is gaining increasing attention in the mineral resource sector. RS is considered as approach for live cycle management (LCM) and sustainable supply chain management (SSCM) (Young, 2018) and refers to the management of sustainability objectives in globalized supply chains (van den Brink et al., 2019). Both the policy sector and industry are implementing RS policies to mitigate and prevent the negative impacts along the supply chains and extend benefits to actors most affected by resource extraction for energy transitions. Considering the need for energy security, some RS initiatives also pursue securing mineral resource supply for renewable energy technologies (Deberdt and Le Billon, 2021). These efforts by the policy sector and industry prompted three research questions that are examined in this paper: (i) What narratives are encompassed by RS literature? (ii) How have these narratives changed over time? (iii) To what degree are aspects of NRJ reflected in these narratives?

## 2. Method

This review paper aims to explore RS literature and investigate the links between NRJ and RS to improve our understanding of (a) different narratives within the discourse and (b) to what degree are the different aspects of NRJ considered in these narratives. For this purpose, a bibliometric network analysis was conducted and complemented by a qualitative content analysis of RS literature (e.g., Chen et al., 2020; Glass et al., 2012b; Mancini et al., 2021) as described in the following chapters.

### 2.1. Data collection and analysis

The Scopus- and Web of Science (WoS) databases were used for a Boolean literature search without any time limitation. While the Scopus-database offers a notably larger coverage of this topic (see also Norris and Oppenheim (2007)), WoS complements the search with high-level publications. Focusing on RS in the renewable energy sector, different queries were conducted using Boolean operators and synonyms (see van den Brink et al. (2019) sustainable sourcing, sustainable procurement) to ensure comprehensiveness. The analysis exclusively focused on scholarly literature and discourses (Scopus/Web of Science indexed articles, editorials, book chapters) and does not reflect on industry-, government- or NGO-related policies, strategies, guidelines, reports or reporting schemes. A first screening indicated a low degree of recognition of RS in the discourses of renewable energy. Therefore, additional queries were conducted to expand the scope to other sectors and raw materials (i.e., minerals and metals, biomass, construction, e-mobility, electronics, food and beverages, cotton and textiles, and retail), to allow a comparison and evaluation of aspects elaborated for other sectors that might be relevant for renewable energy supply chains (Fig. 1). The



The first identification of publications during the data collection was followed by a four-step data-cleaning process: (i) removing of duplicates, which leaves 414 publications; (ii) title, abstract and keywords were screened to determine whether the publications are relevant for the topic of this study. Criteria to evaluate relevance were the

mentioning of RS or synonyms, supply chain management or subdivisions such as ethical sourcing or green procurement (van den Brink et al., 2019); focus on sourcing practices of organizations, and supply chain due diligence approaches by voluntary initiatives or regulators. (iii) Patents (3), supplementary material (2) and texts in languages other than English or German (9) were omitted as the main language of the RS discourse is English. After this second elimination round, 172 publications remained for full-text analysis. (iv) Another 26 relevant articles were added to the short-list that were identified by reviewing reference lists of included publications and an additional

search for the years 2021 and 2022 was conducted to include the most recent articles (Fig. 2).

## 2.2. Content and bibliometric network analysis

Before the qualitative content analysis, a bibliometric network analysis was conducted. This was done to assess the network of occurring keywords and investigate the clusters formed by interconnected papers using VOSviewer. For this purpose, bibliographic data from Scopus was exported for all publications included in the full-text assessment (198 publications). VOSviewer produced a co-occurrence analysis of author keywords applying the full counting method following previous research (Wangsa et al., 2022). Two occurrences were used as the threshold to exclude 'outliers'. Data cleaning was performed with a 'thesaurus file' to avoid spelling variations or abbreviations of the same keyword (e.g., CSR and corporate social responsibility or sustainable development and sustainable-development) are counted separately, resulting in 585 unique keywords. The minimum cluster size was set at three and two keywords that do not form a cluster were excluded from further analysis. This analysis provides an overview of the key topics associated with RS and their links in the respective literature (van Eck and Waltman, 2022). The clusters identified provide a basis for the inductive coding of the RS discourse. The VOSviewer network also gives the opportunity to examine the development of the topics and their co-occurrence over time by using the 'overlay visualization' (van Eck and Waltman, 2014).

For the content analysis, a two-pronged approach was applied: (i) inductive coding, to identify the scope of RS and categorize them by emerging topic (e.g., sector addressed, and sustainability dimension(s) included); (ii) to better assess NRJ and use it as a conceptual lens, the authors used a deductive approach (Spiggle, 1994) based on core-literature of the academic discourse (Armstrong, 2013, 2017; Blomfield, 2019; Crawford and Botchwey, 2017; Moore, 2012; Pichler et al., 2017; Schmitt, 2017; Sweetman and Ezpeleta, 2017) and addressed core NRJ aspects (Table 1).

In the first round of the full-text assessment, the authors decided to omit literature on life-cycle assessments (LCAs) unless they contain specific references to responsible or sustainable sourcing (such as Munasinghe et al. (2016)). While LCAs are certainly an important source of quantifiable data on environmental impacts along the supply chains of different technologies, they do not necessarily contain information on how the sourcing itself is conducted. Additionally, LCA literature focuses on technical aspects of capacity development as well as financial concerns associated with risks in supply chains (Kramarz et al., 2021) which is a too narrow perspective for this study. The remaining RS literature was examined for commodities covered, and different drivers for and aspects covered by RS initiatives to find out significant commonalities and differences. These results served as the basis for mapping and discussing NRJ.

## 3. Results

In general, the literature on RS has been increasing since 2019 (Fig. 3). Since 2019 87 articles have been published. With 40% of these papers, mineral resources are becoming a prominent topic in this period and minerals and metals for energy transitions are gaining importance. However, only six papers in this period investigated renewable energy supply chains directly. The data collection was conducted in early 2022, explaining the lower number of publications in this year (Fig. 3).

The examined RS literature covers to varying degrees one or more of three core sustainability dimensions, social, environmental, and economic. The bibliometric network analysis showed 84 author keywords that occur at least twice in the included publications and formed eleven distinctive clusters (Fig. 4). The titles of the clusters are based on the two key words with the most occurrences and highest link strength within each cluster (details see Supplementary Material). The largest cluster with thirteen items covers sustainable development and the promotion of a circular economy. Green supply chain management and considerations of carbon and water footprint are of concern. Renewable energy is only marginally addressed in cluster one. Only a few publications discussed the social and environmental impacts of energy transitions (Kramarz et al., 2021; Watari et al., 2021), the carbon and water footprint of wind energy supply chains (Lundie et al., 2019), or potential ways to enhance the reuse of wind turbine blades through green public procurement (Nagle et al., 2022). Otherwise, cluster two on biomass is more prominent in this respect. The second cluster (11 items) pursues sustainable forest management for biomass sourcing under relevant EU regulations. Cluster three (10 items) concentrates on the aspect of sustainability mainly within the UK construction industry. Two of the clusters consist of three elements only, each including RS and corporate social responsibility (CSR) two of the most frequently occurring topics. These two essential keywords are strongly interlinked with all areas, this is why they are not considered separately in this analysis. While different minerals and metals spread across various clusters, the results obtained show specifics: cluster one covers zinc and its relevance for the SDGs; clusters five and eight emphasize conflict minerals and cobalt, and cluster six focuses on critical minerals (e.g., rare earth elements). The analysis shows that the clusters not only differ in terms of included items but also concerning their thematic scope. While some clusters are specifically addressing certain commodities (e.g. cluster eight: cobalt), others focus on certain conceptual approaches (e.g. cluster four: sustainable sourcing) (Table 2). Even though the narrower clusters contain less items, the discourses are pronounced enough and statistically significant that they merge as distinctive clusters. The following subsections introduce clusters one to nine in more detail and examine the concepts involved, as well as the coverage of the NRJ. Finally, the authors discussed similarities, tensions, and contradictions between the clusters and considered the thematic evolution over time.

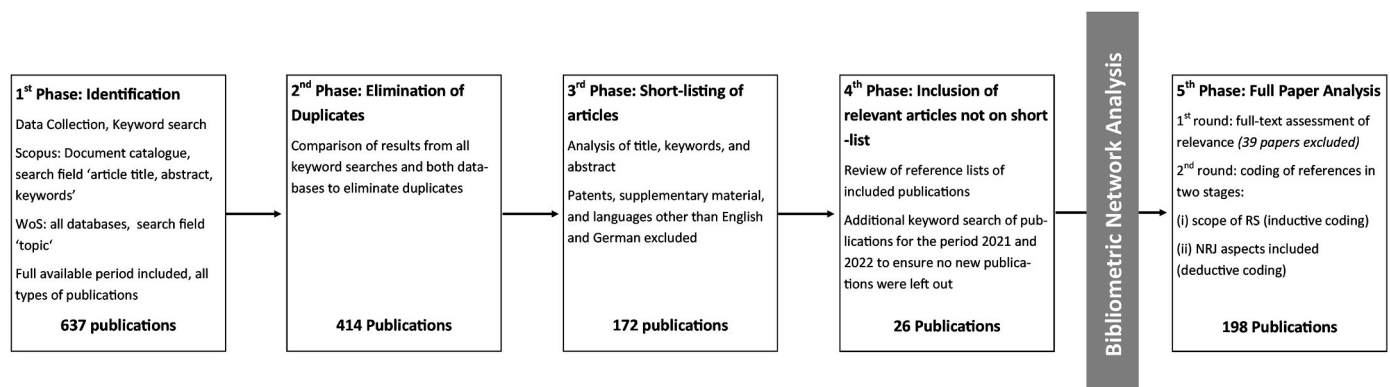


Fig. 2. Data collection and data cleaning as preparation for content analysis (based on Zorzini et al. (2015)).

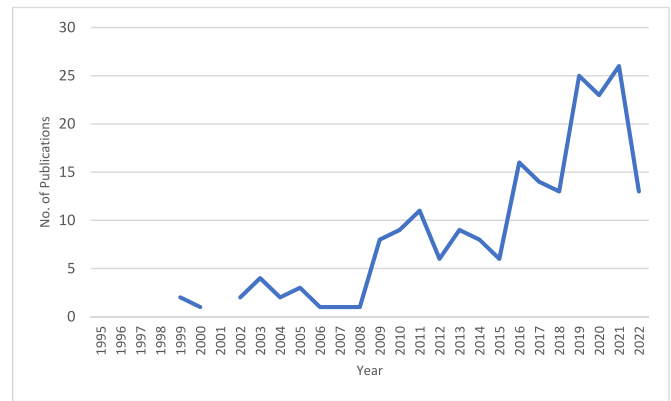


**Table 1**  
Deductive NRJ codes for mapping and as a conceptual lens for the discussion.

Aspect/Code	Theoretical aspect/conceptual lens	Leading Authors
Distribution of benefits and burdens	Distributive justice considers the distribution of benefits and burdens derived from natural resource production and use. Benefits of natural resources are limited and unequally shared, communities most affected by burdens such as land use or pollution are often the ones benefiting the least from profits made.	Armstrong, 2017; Sweetman and Ezpeleta, 2017
Access to and control of natural resources	The national development and well-being of the population should be at the center of natural resource use (United Nations, 1962). However, these considerations often take a back seat and any benefits gained are not sustainable. Increasing demand and resource-intensive modes of living, price volatility, etc. led to competition and conflicts for access to and control of resources.	Pichler et al., 2017; Syme, 2017
Gender equality and women's rights	A key aspect of sustainable development is the promotion of gender equality and women's rights. Compared to men, women living in poverty are less likely to be involved in decision-making processes regarding extractive operations, that can however, have even more devastating effects on their livelihoods and security.	Sweetman and Ezpeleta, 2017; The WoMin Collective, 2017
Resource curse	The resource curse refers to the potentially adverse effects of resource possession on a country's economic, social, and political well-being. It also leads to a confounded ability of local communities to self-determined living.	Bebbington et al., 2018; Blomfield, 2019
Power relations	Who has the power to make decisions over the use of natural resources including mineral resource extraction and the potential (negative) consequences such as land use, biodiversity loss, or environmental pollution?	e.g., Martinez-Alier et al., 2010
Accountability	Accountability as part of procedural justice considerations refers to political decision-makers and industry members being held accountable for their actions. A mechanism ensuring the accountability of decision-makers that have the power to control natural resources is required to ensure they are not only used for the benefit of the elite.	Dare and Schirmer, 2017; Moore, 2012

### 3.1. Cluster one (red): Sustainable Development and Circular Economy

The narrative of this cluster mainly focuses on sustainable development and sustainable production, and sought to understand the environmental dimension of supply chain management ('green SCM'). Related to green SCM, particularly the water and carbon footprint of diverse technologies and sectors are explored and reduction potentials are investigated as well. Here, the narrative focuses on the systemic



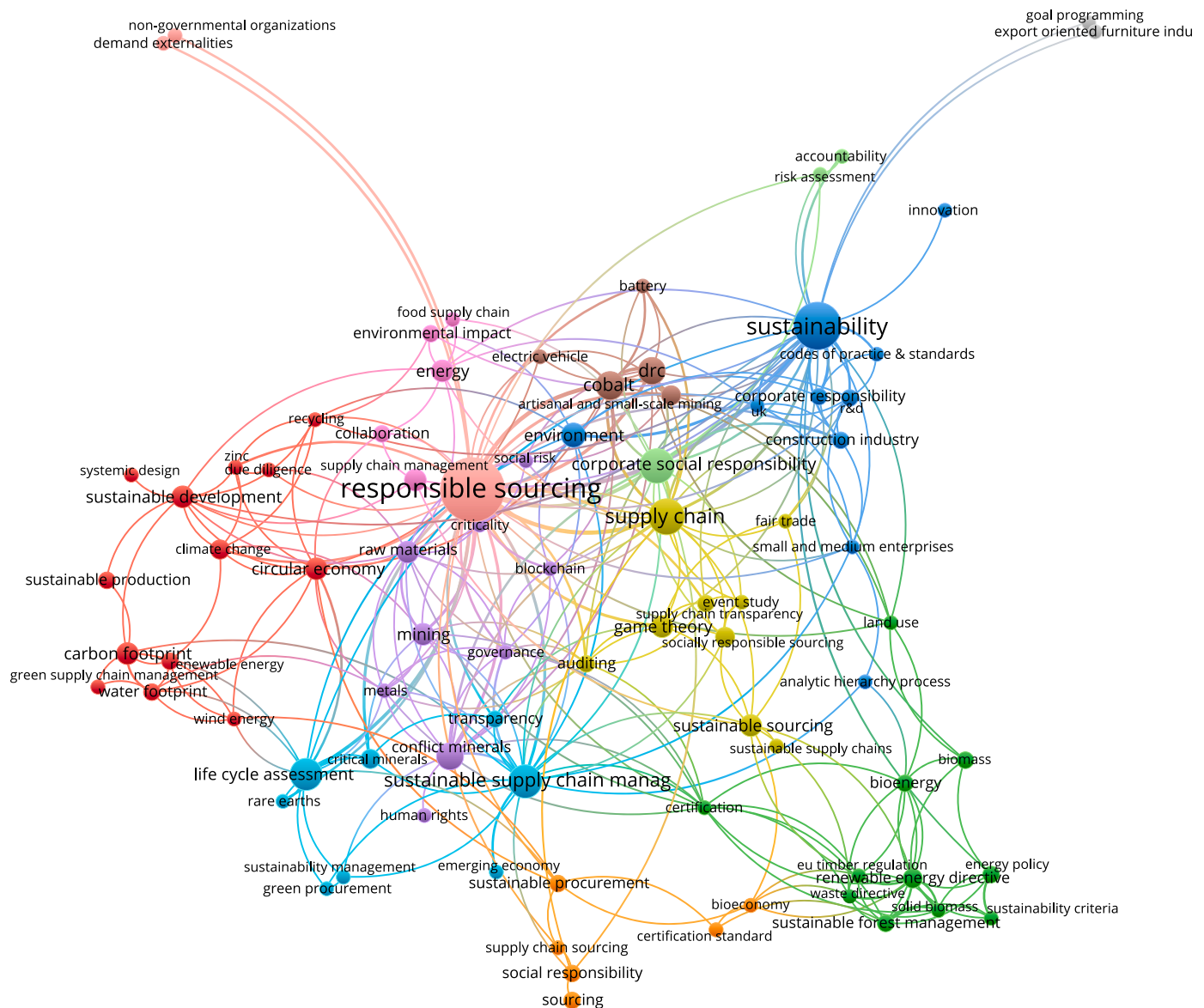
**Fig. 3.** Number of RS publications per year between 1995 and 2022; data collection for this study was conducted in early 2022, explaining the low number of publications in 2022; no publications were found for 1995–1998 and 2001.

nature of resource consumption and reduction capacities; using recycling and end-of-life (EoL) products is expected to support this reduction by reducing material intensity (e.g., Grund and van Genderen, 2020; Witjes and Lozano, 2016). Zinc is an example of a material crucial for energy transitions and the achievement of the SDGs that could provide a model for other mineral supply chains. The industry has a well-established system of LCAs and analyses of material stocks and flows, providing important information on environmental hotspots as well as available recycling systems (Grund and van Genderen, 2020). The importance of a functioning recycling system and a secure supply of secondary raw materials for energy transitions is also highlighted in the case of cobalt. The lack of standardization and systemic thinking in the design and planning of car batteries, however, still prevents such a system (Earl et al., 2022).

Public procurement is seen as a potential way to enhance usage efficiency and promote sustainable business models by including social and environmental criteria in product specifications (Witjes and Lozano, 2016). This proposal establishes a link to cluster nine in which collaboration between procurers and suppliers is pivotal to improving the circular economy and ensuring economic benefits for both parties. Green public procurement is considered an important instrument to govern the demand for EoL wind turbine blades while also creating jobs in high unemployment areas (Nagle et al., 2022). They investigate different repurposing concepts regarding their environmental impacts to determine the best reuse scenarios, potentially diverting 20% of Ireland's blade waste to alternative EoL solutions. Another approach is the development of networks between companies to allow for the maximum use of resources and waste reduction. Linking companies with IT networks would allow one company to source the waste of another company. Therefore, the model promotes local sourcing, decreases pressure on natural resources and the environment, and adds economic value through the valorization of waste (Ceppa, 2010, 2011).

### 3.2. Cluster two (green): Renewable Energy Directive and Sustainable Forest Management

The narrative of this cluster centers on wood, timber, and biomass imports of the EU that are required to meet the set targets on renewable energy. These debates emphasize the EU's swiftly increasing demand for biomass and the need for RS to prevent the offset of this positive trend by causing significant environmental degradation (Allen et al., 2013; Finerman et al., 2019). Based on the EU Timber Regulation for legal sourcing of wood, and the Renewable Energy Directive (RED), various EU member states have therefore introduced sustainability requirements for legal and sustainable sourcing of wood and solid biomass (Sikkema et al., 2017). The adherence to these requirements can be proven via



**Fig. 4.** Bibliometric network analysis (VOSviewer) showing thematic clusters of RS literature: Cluster one (red) Sustainable Development and Circular Economy; Cluster two (green) Renewable Energy Directive and Sustainable Forest Management; Cluster three (blue) (Environmental) Sustainability and Construction Industry; Cluster four (yellow) Supply Chain and Sustainable Sourcing; Cluster five (purple) Conflict Minerals and Raw Materials; Cluster six (turquoise) Supply Chain Management and Life Cycle Assessment; Cluster seven (orange) Sustainable Procurement and Social Responsibility; Cluster eight (brown) Cobalt and the DRC; Cluster nine (pink) Energy and Supply Chain Management. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

sustainable forest management certification schemes, such as the Forest Stewardship Council's (FSC) Principles and Criteria, or the Program for the Endorsement of Forest Certification (PEFC) schemes (Sikkema et al., 2014). Even though FSC and PESC include all three sustainability dimensions in their frameworks (Barnett, 2016), literature on RS in the biomass and wood industry tends to focus more on environmental issues. Considerations include biodiversity conservation and protection of wetlands or primary forest areas (e.g., Galik and Abt, 2016; Sikkema et al., 2021).

### 3.3. Cluster three (blue): (Environmental) Sustainability and Construction Industry

This cluster has a strong focus on environmental sustainability in various sectors (e.g., construction, food, and textiles). Previous research

that reflected on the UK construction industry is dominant. Even though this discourse does not directly relate to the renewable energy sector, materials used in the construction sector are highly relevant for renewable energy technologies; e.g. concrete for wind turbine foundations. In this sector, RS covers the requirements for environmental and social sustainability, organizational-, and supply chain management criteria including legal compliance, management systems, and traceability (e.g., Glass, 2011; Upstill-Goddard et al., 2015; Young and Osmani, 2013). RS is considered as part of sustainable procurement and corporate responsibility to help companies improve their supply chain transparency and traceability and show how responsible they are (Glass et al., 2012a). A major question that the cluster addresses on a recurring basis is whether the availability of standards is sufficiently raising awareness on RS among SME-construction companies that might lack the capacity to invest in and conduct a certification process of their

supply chains. Overall, a lack of awareness among SMEs of RS was identified. This lack is further aggravated by the lack of external drivers, incentives and regulations to implement RS since neither government nor clients have included such criteria in their contracts yet (e.g., Glass et al., 2012a; Young and Osmani, 2013).

Cluster three is rather broad in scope and not all RS initiatives are directly applicable to the renewable energy sector. However, the issues of transparency, R&D, and innovation addressed in this cluster are of universal relevance. Different industries (e.g. the chocolate industry) explore unique biomarkers for the identification of products' origins. Related sustainability efforts and measures to reduce supply risks also target the management of deforestation, the elimination of child labor, and the mitigation of other socio-environmental problems (Lafargue et al., 2021). Luxury retail brands have the potential to drive innovation to improve the performance of production systems, products and ultimately environmental and social impacts in their supply chains. An example of the need for innovation is cotton production that, even though a shift to organic production methods is noticeable, still has a significant environmental impact, and price and supply insecurities lead to critical challenges for both suppliers and buyers (Karaosman et al., 2017).

### 3.4. Cluster four (yellow): Supply Chain and Sustainable Sourcing

Cluster four illustrates dimensions that can impact entire supply chains of various sectors (e.g. supply chain transparency, sustainability of supply chains). With socially RS and 'fair trade', this cluster strongly covers the social dimension of sustainability in supply chains covering topics such as human rights, occupational health and safety (OHS), local development, diversity and ethical aspects in fair trade initiatives (Zorzini et al., 2015): fair trade in the cotton supply chain pursues sustainable farming and improved livelihoods through trade conditions and also covers the environmental dimension (e.g. funding clean water initiatives; development of novel farming methods) (Dai et al., 2020). Although this cluster covers fair trade in the cotton sector, similar discourses also emerge around mineral supply chains, e.g. diamonds and gold (such as Hilson et al. (2016)) as well as relevant minerals for renewable energy technologies (e.g., Watzel (2022)).

Supplier auditing and game theory are additional themes addressed in this cluster. For buyers, auditing is one possibility to determine whether suppliers comply with social and environmental standards (e.g., Young, 2018; Zhang et al., 2022). While the selection of auditing schemes and mechanisms is one-sided (Zarei et al., 2020), the buyers also have varying leeway and response options for non-compliance. These responses can cover the full spectrum from dropping or rectifying suppliers to ignoring non-compliance (Zhang et al., 2022). The debate on game theory underscores its capacity to optimize decisions in production and procurement management in the context of RS (Lapunka et al., 2016; Ma et al., 2022; Zarei et al., 2020). Both themes are relevant for a wide range of supply chains including mineral resources for renewable energy technologies.

### 3.5. Cluster five (purple): Conflict Minerals and Raw Materials

Literature on RS for minerals and metals has been increasing since 2019 focusing on conflict minerals (i.e., the '3 TG' – tin, tungsten, tantalum, and gold) (C5) and cobalt from the Democratic Republic of the Congo (DRC, C8). Even though their main applications lie elsewhere, tin (for solar power) and cobalt (for wind power) supply are relevant for the renewable energy sector (Vakulchuk et al., 2020). The discourse on conflict minerals tends to be concerned with social risks, particularly human rights (e.g., Young, 2018). The authors acknowledge the importance of frameworks, e.g., the OECD Due Diligence Guidance on Responsible Supply Chains for Conflict-Affected and High-Risk Areas, and regulation such as the US Dodd Frank Act and the EU Conflict Minerals Regulation on RS efforts in this sector (such as Sarfaty, 2015).

However, they also point out potentially unintended consequences and negative effects on social sustainability (Diemel and Hilhorst, 2019). The discourse on conflict minerals views RS as part of an organization's CSR (Airike et al., 2016; Deberdt and Le Billon, 2021) and SSCM (C6) (Young, 2018). Blockchain has recently become a technology of increased interest in minerals and metals supply chains, particularly conflict minerals', to improve transparency and traceability (Mugurusi and Ahishakiye, 2022). Another perspective argues that the SDGs and Paris climate targets cannot be met without mitigating the socio-environmental impacts of extracting mineral resources for low-carbon technologies (e.g., Ali et al., 2017; Mancini and Nuss, 2020) and agree that the three sustainability-dimensions are all equally important in the supply of mineral resources.

### 3.6. Cluster six (turquoise): Sustainable Supply Chain Management and Life Cycle Assessment

The sixth narrative revolves around SSCM and LCAs to assess and manage the socio-environmental impacts of supply chains and supply security (Lee et al., 2020). Critical minerals and rare earth elements (REE) play a pivotal role in this narrative, in particular due to their importance for low-carbon technologies. LCAs are considered a useful tool to compare the environmental performance of different extraction and processing methods of critical minerals that covers a broad range of environmental problems (Wall et al., 2017; Wall and Pell, 2020). Even though LCAs provide crucial information for RS, their focus on energy use, global warming impacts, and/or GHG-emissions can lead to other environmental and social impacts not (or not sufficiently being) accounted for in RS efforts (Wall et al., 2017). Depending on the sector and supply chain structure, SSCM has different implications: (i) SSCM for supply chains of the garment industry considers the adoption of environmental management systems, the use of sustainable raw materials, worker safety and welfare, gender equality, no child- and forced labor (Nayak et al., 2019); (ii) high-tech industries consider the triple bottom line (TBL) in SSCM as part of the CSR agenda - elements include the lifetime of products, the use of 'green' components and materials, as well as improved market performance and corporate image (Yan et al., 2016); and (iii) in the mineral resource sector, buyers are struggling with complex supply chains and limited transparency. Strategies for SSCM such as communication, education, development and compliance to ensure environmental and social standards are met by suppliers, are difficult to apply given the limited upstream visibility. Direct engagement with focal companies that can lead the implementation of standards further upstream, the use of third-party or industry initiatives, or closed-pipeline systems have been identified as adequate responses to these challenges (Young et al., 2019).

### 3.7. Cluster seven (orange): Sustainable Procurement and Social Responsibility

The debate in cluster seven examines buyers' sourcing strategies and their potential impact on suppliers' behavior (Agrawal and Lee, 2019), strategy making/development (Guo et al., 2016) and the impact of socially RS of operating efficiency (Joo et al., 2010). RS policies vary in scope and influence on suppliers. A rough distinction can be made between 'sustainable preferred' and 'sustainable required'. Sustainable required means a company only buys sustainable products, which is the better policy to initiate a change in supplier behavior in the case of a single supplier. In the case of several suppliers, sustainable preferred, i.e., a company buys both unsustainable and sustainable products but prefers the latter if available, is more likely to encourage suppliers to offer sustainable products (Agrawal and Lee, 2019). The introduction of RS policies cannot only impact the supplier's behavior, but also the buyer's performance. In food supply chains, e.g., coffee retailers who demonstrate social responsibility in the form of fair-trade practices tend to achieve higher operating efficiencies, improved reputation, and

competitiveness (Jacob-John et al., 2020; Joo et al., 2010). Still, the decisive driver for buyers to introduce RS practices is often the consumer's interest in environmentally- and socially-friendly goods/services (Guo et al., 2016; Kormann and Kicherer, 2015).

### 3.8. Cluster eight (brown): Cobalt and the DRC

Cluster eight illustrates the sourcing of cobalt from the DRC and associated topics of artisanal and small-scale mining (ASM) for electric vehicles or batteries. The importance of cobalt for green technologies (including energy storage and wind turbines) explains the increase of novel RS schemes (Deberdt and Le Billon, 2022) and the formalization of ASM and integration in global supply chains is critically addressed (e.g., Calvão et al., 2021; Deberdt, 2022). ASM is also relevant for other minerals critical for renewable energy technologies (e.g., copper mining in the African Copperbelt (Calvão et al., 2021)), and initiatives from cobalt supply chains could be used as a blueprint for other mineral supply chains. Since RS initiatives are mainly driven by downstream actors trying to achieve supply security and reduce reputational risks, they are expected to alleviate societally unacceptable pressures such as child labor, corruption, OHS and environmental damages that negatively impact business performance (Mancini et al., 2021). However, the artisanal and small-scale miners themselves might not be able to profit extensively in the form of higher income or price stability (Deberdt and Le Billon, 2022; Mancini et al., 2021).

The DRC recently established the Enterprise Générale du Cobalt (EGC), a state-owned organization that is supposed to act as an intermediary between ASM and industry and address the issues of price fluctuations. Therefore, it is expected that the implementation ensures compliance with social and environmental standards. The potential benefit for buyers is the possibility to outsource their own due diligence responsibilities to EGC. However, the actual on-the-ground impact of the EGC remains to be seen (Deberdt, 2021).

### 3.9. Cluster nine (pink): Energy and Supply Chain Management

Literature on SCM in cluster nine discusses the potential of achieving social and environmental sustainability aspects through collaboration between supply chain actors; e.g., for water and energy conservation (Hasan and Leonas, 2018), improved workplace safety (Awasthy and Hazra, 2019), or a more circular economy (Witjes and Lozano, 2016). Signified by the frequent keyword 'energy' the narrative mainly revolves around energy conservational efforts. Here, the scope of the discussion involves measures in clothing industries (Hasan and Leonas, 2018), construction (Elliot and Palmer, 2002), and energy supply chains (e.g. oil and gas) (Yusuf et al., 2013). Different examples, such as the UK oil and gas sector, illustrate the relevance of actions that reduce energy- and water consumption, followed by waste management and improved working conditions on company level (Yusuf et al., 2013). In the supply chains of renewable energy companies, measures to mitigate conflicts in host communities are gaining salience. Incorporating ethical sourcing and 'corporate peacebuilding' in the supply chains of conflict minerals are recent debates (Ralph and Hancock, 2018).

Collaboration can either be established by a buyer directly engaging with a supplier during a procurement process potentially enhancing performance while improving resource use and reducing waste (Witjes and Lozano, 2016). Or collaboration can take the form of industry multi-stakeholder initiatives as examples from the textile industry demonstrate (e.g., the Responsible Sourcing Initiative or the Partnership for Cleaner Textile). This kind of collaboration between actors of different supply chain stages, non-governmental organizations, and governments allows the identification and management of industry-wide issues (Hasan and Leonas, 2018) (see Table 2).

**Table 2**

Key themes and authors of identified clusters.

Cluster No.	RS Narrative	Key aspects of the narrative	Exemplarily, identified core articles
One	Sustainable development and circular economy	Sustainable production, carbon and water footprint, recycling, climate change and renewable energy	Ceppa (2010, 2011), Dey et al. (2011), Earl et al. (2022), Grund and van Genderen (2020, 2021), Kramarz et al. (2021), Nagle et al. (2022), Robins and Kumar (1999), Sirilertsuwan et al. (2020), Witjes and Lozano (2016)
Two	Renewable Energy Directive and sustainable forest management	Bioenergy, (solid) biomass, energy policy, waste directive, land use, sustainability criteria	Allen et al. (2013), Barnett (2016), Galik and Abt (2016), Larsen et al. (2019), Mai-Moulin et al. (2017), Pelkmans et al. (2017), Scott et al. (2013), Sikkema et al. (2014, 2017)
Three	(Environmental) sustainability and construction industry	Corporate responsibility, environment, innovation and R&D, small and medium enterprises, UK	Gerbens-Leenes et al. (2003), Glass (2011), Glass et al. (2012a,b), Karaosman et al. (2017), Lafargue et al. (2021), Upstill-Goddard et al. (2015, 2016), Young and Osmani (2013)
Four	Supply chain and sustainable sourcing	Game theory, supply chain transparency, socially responsible sourcing and fair trade, auditing	, , , Dai et al. (2020), de Zegher et al. (2019), Lapunka et al. (2016), Shao et al. (2020), Young (2018), Zarei et al. (2020), Zhang et al. (2022), Zorzini et al. (2015)
Five	Conflict minerals and raw materials	Mineral criticality and governance, social risk and human rights, mining, metals, blockchain	Airike et al. (2016), Dalla Via and Perego (2018), , Diemel and Hilhorst (2019), Mancini and Nuss (2020), Mugurusi and Ahishakiye (2022), Sarfaty (2015), Young (2018)
Six	Sustainable supply chain management and life cycle assessment	Critical minerals and REE, green procurement, sustainability management and transparency	Fontana et al. (2021), Lee et al. (2020), Nayak et al. (2019), (Ofori, 2000), Wall and Pell (2020), Wall et al. (2017), Yan et al. (2016), Young et al. (2019)
Seven	Sustainable procurement and social responsibility	Sustainable procurement, supply chain sourcing, social responsibility, certification standards, bio-economy	Agrawal and Lee (2019), Bragg and Alexander (2019), Guo et al. (2016), Jacob-John et al. (2020), Joo et al. (2010), Kormann and Kicherer (2015)
Eight	Cobalt and the DRC	Batteries and electric vehicles, artisanal and small-scale mining	Brown et al. (2020), Calvão et al. (2021), Deberdt (2021, 2022), Deberdt and Le Billon (2022), Mancini et al. (2021), Schütte and Näher (2020), Zeuner (2018)
Nine	Energy and supply chain management	Supply chain management, collaboration,	Awasthy and Hazra (2019), Dey et al. (2011), Hasan and

(continued on next page)



Table 2 (continued)

Cluster No.	RS Narrative	Key aspects of the narrative	Exemplarily, identified core articles
		energy conservation and ethical sourcing for renewable energy	Leonas (2018), Jacobs and Singhal (2020), Ralph and Hancock (2018), Tacon et al. (2009), Witjes and Lozano (2016), Yusuf et al. (2013)

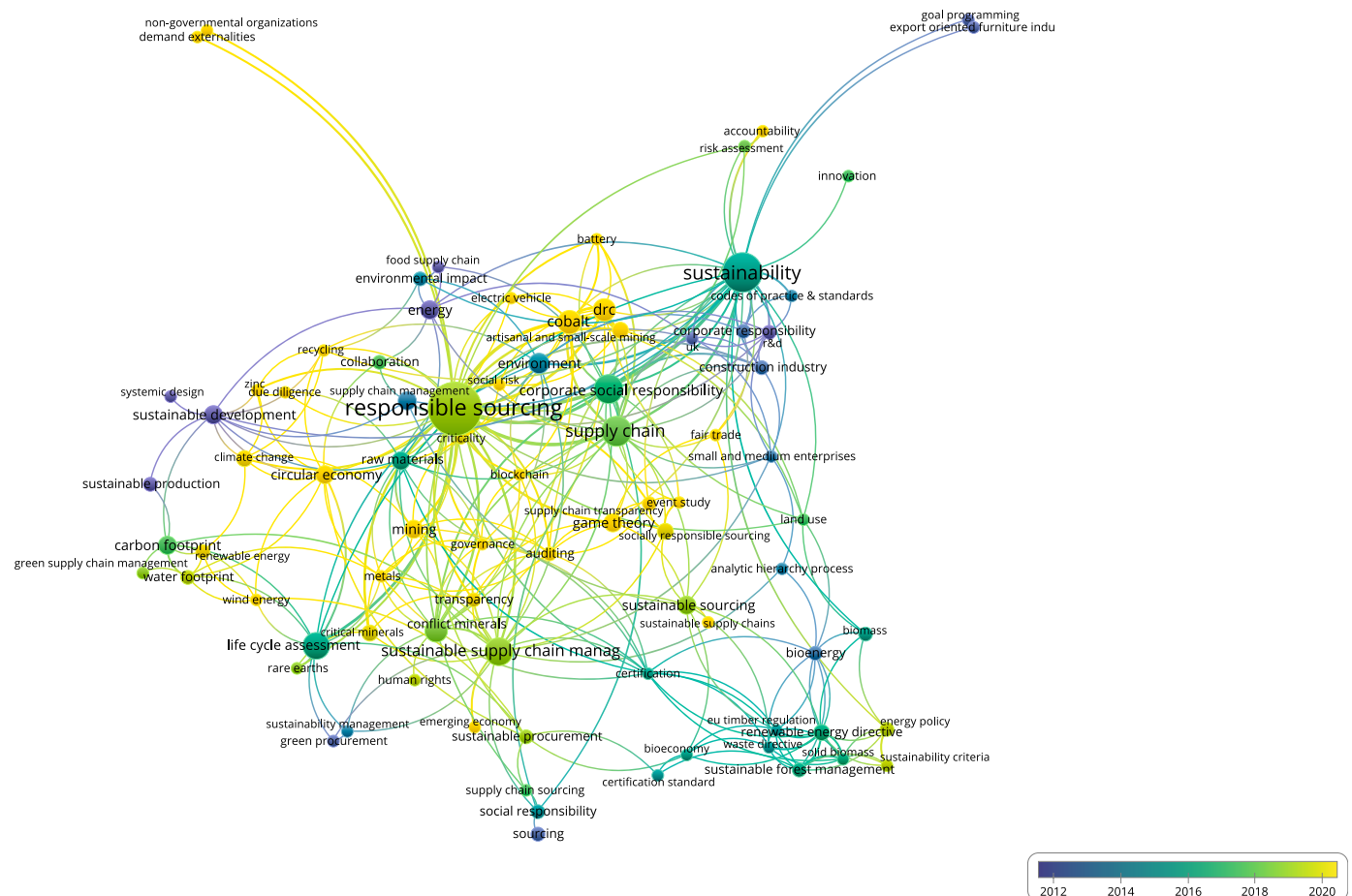
### 3.10. Thematic evolution over time

The timeline for the thematic evolution (Fig. 5) shows that the RS discourse is gradually changing its focus. More traditional issues such as sustainable development and sustainable production, green procurement, the construction industry, and food supply (blue/purple circles in Fig. 5) seem to form the roots of the RS debate but are becoming increasingly outdated. A more recent part of the discourse, approximately in the middle of the timeline, deals with sustainability in general. The debate moves away from ‘standard’ SCM towards green and sustainable SCM including LCAs, and (corporate) social responsibility (turquoise to green circles). The narrative of this timeframe centers around biomass and conflict minerals. The yellow circles show topics that are emerging since 2020 which turn attention to governance and broader justice-related issues such as transparency and fair trade. Climate change and circular economy become key topics and the discourse focuses on green technologies and battery materials (e.g., wind energy and cobalt). Considering the thematic clusters of the RS

literature (Fig. 4), cluster one illustrates the evolution of topics particularly well. The narrative of cluster one moves from a broad focus on sustainable development and production to green SCM including water and carbon footprint of products. Recently, the discourse in this cluster examines issues related to climate change, recycling, and due diligence.

#### 4. Discussing responsible sourcing narratives through the lens of natural resources justice

While the calls for ethical and just approaches to energy transitions are increasing (e.g. [Byсков et al., 2021](#); [Gillard et al., 2016](#)), our results illustrate that the RS discourse is yet to embrace them. Currently, RS is rather considered as a means to secure access to raw materials and markets and NRJ is not directly and holistically addressed. For the mineral resource sector, our results align with previous studies ([Heffron, 2020](#); [Qurbani et al., 2021](#)), finding a lack of holistic justice considerations in extractive operations. Recent research tends to indirectly address justice by identifying certain topics or problems without explicitly referring to the already well-established justice discourses in other academic fields. Apart from the resource curse ([Bebbington et al., 2018](#); [Blomfield, 2019](#)) which is not addressed in the included literature, the RS narratives modestly cover the considered NRJ aspects: justice and equity have entered the debate to a minor degree, even if the communities' rights and needs are primarily discussed to gain or maintain the 'Social License to Operate' (SLO). While originally rooting in (conflict mitigation in) mining and mineral resource governance, more recently SLO is also used as a conceptual model in neighboring discourses and industries such as the renewable energy sector, e.g. for onshore wind farms, and is considered crucial for a successful energy transition



**Fig. 5.** Overlay visualization (VOSviewer) showing thematic evolution of RS literature over time (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.).

(Gehman et al., 2017; Lesser et al., 2021; Poelzer et al., 2022; Stephens and Robinson, 2021; Wood et al., 2022). The challenging subject of ASM and associated human rights violations and environmental degradation fuels debates on governance and traceability schemes to reduce conflicts and protect livelihoods (Diemel and Hilhorst, 2019). The largest cluster (C1) explicitly refers to justice and equity in energy transformations. The results obtained show that these discussions are limited to very few publications.

#### 4.1. Distributive justice

The current discourse considers only some minor aspects of distributive justice: while some authors investigated different approaches by companies to implement RS, such as closed-pipeline systems enabling a full life cycle chain of custody and ASM to participate in trade and benefit economically (Young, 2018), other authors demonstrated the shortcomings of existing RS interventions that resulted in a boycott of ASM in conflict-regions endangering livelihoods (e.g., Dalla Via and Perego, 2018; Diemel and Hilhorst, 2019) (see C5). Disclosing the social, environmental, and economic benefits and burdens of renewable energy supply chains are needed to identify required interventions to trigger and establish just energy transitions. One possible approach is the development and application of an interpretive framework of environmental governance practices' impacts on the capabilities of communities and ecosystems (Kramarz et al., 2021) (C1). Other approaches to realizing mutual benefits among supply-chain partners include: (i) Contractual management and system thinking to develop trusted relationships and create shared value (Yan et al., 2016; Zegher et al., 2019); and (ii) Fair trade to empower communities and provide sustainable livelihoods while realizing reputational and qualitative improvements for the buyer (Dai et al., 2020) (C4).

Downstream actors consider distributive justice as one possibility to decrease reputational risks while being able to enter new markets and attract ethically conscious consumers (Guo et al., 2016). The results obtained show that distributive justice is considered to the extent that companies can use it for their benefit: mainly to access raw materials and markets but not to advance NRJ. Quite the opposite, RS initiatives can further push the burden towards the weakest supply chain members and lead to novel forms of dispossession; e.g., ASM is facing increasing economic uncertainty due to price fluctuations and job insecurity (Calvão et al., 2021). Considering further challenges for ASM including human rights violations and environmental degradation, the debate on governance and traceability schemes seems too narrow. The discussion should not be about allowing companies to benefit from the sales of responsibly sourced products to conscious consumers, while merely protecting livelihoods. Hence, the debate must include the development of instruments and conditions where all actors get "their fair share in proportion to their risk-taking, input and creativity" (Mazzucato, 2020, p. 189) which also includes a just (re-) (pre-)distribution of created value (Mazzucato, 2020). In this regard, distributive justice will become progressively relevant due to its importance for small-scale miners for the supply of transition minerals such as cobalt or copper.

#### 4.2. Access to and control of natural resources

One of the main limitations of RS efforts in cobalt supply chains is the focus of downstream industries on reputational risks such as child labor or OHS, while other aspects that would benefit the local population and ASM miners themselves are ignored (Deberdt, 2022; Mancini et al., 2021). Dispossession and the granting of mining concessions on land with already existing forms of land tenure can lead to conflicts, deprive the population of land access (Deberdt, 2022) and negatively affect property rights regimes (e.g., Schlager and Ostrom, 1992). Current RS initiatives can lead to the exclusion of ASM from international markets and a trend to push miners into alternative livelihoods can be observed (Diemel and Hilhorst, 2019). Access to economically and geologically

viable lands must be addressed in the future to ensure sustainable livelihoods of mining communities (Deberdt, 2022) (C2, 5, 8). Our results of RS initiatives and their impacts support the findings of previous studies pointing towards the emergence of green- or resource colonialism (Normann, 2021) and green extractivism (Dunlap and Marin, 2022; Jerez et al., 2021). The access of the local population not only to economically viable land, but also to essential natural resources is largely ignored in RS initiatives and debates. The issue of control of the use of natural resources by the local population as well as the right to say no or free prior informed consent, key aspects of NRJ, are currently not part of the RS discourse.

#### 4.3. Gender equality and women's rights

The research shows that different aspects of gender equality are considered in RS discourses around biomass, aquaculture- and fashion industries, such as equal opportunities and benefits created for women, contribution to economic development, power relationships, right to maternity leave, prevention of sexual abuse and discrimination (Nayak et al., 2019; Rakotovo et al., 2018) (C6). Especially for women located in rural areas, employment results in female- and household empowerment and subsequently provide socio-economic benefits for families and communities (Tacon et al., 2009) (C9).

Even though neighboring discourses are engaged in vivid debates on the under-representation of women in decision-making processes (e.g., Buchy and Maconachie, 2014; Nightingale et al., 2017), gender equality and the role of women are not yet adequately considered in the RS discourses, despite the significant role women play e.g. in mineral resource extraction (Mancini et al., 2021). Hence, gender-sensitive approaches in the assessment and management of socio-economic affairs of extractive industries are required to critically evaluate impacts, opportunities and possible benefits of extractive operations (Nightingale et al., 2017).

#### 4.4. Power relations

Downstream companies' sustainability initiatives can potentially harm less powerful suppliers. Therefore it is crucial for companies to consider potential negative effects on the distribution of benefits and burdens in their supply chains (Robins and Kumar, 1999). With regard to ASM, RS, like CSR (Hilson et al., 2019), runs the risk of contributing to resource colonialism rather than the formalization of the sector if power relations are not considered with care. Zeuner (2018) (C8) advocates taxation to solve this problem, since miners would gain bargaining power by paying taxes and multi-national companies lose their sole dominance. However, this argument ignores two key factors: (i) ASM has limited linkages with the economy and most initiatives are only able to integrate better-off ASM operations due to the vast amount of very small and poor producers (Hilson et al., 2018, 2019); (ii) while taxation can be used to create value and build a more inclusive and sustainable economy, this requires more systemic changes and a joint approach towards defining and creating value by all stakeholder groups (Mazzucato, 2020). Other approaches to RS in the mineral resource sector discuss the role of different actors in creating more sustainability. Focal companies (i.e., refiners in the case of minerals and metals) could be the key to driving change in the upstream supply chain since they have considerable market power (Young, 2018) (C5). Also, investors are considered powerful actors that have the potential to influence sustainability in supply chains (Wall and Pell, 2020) (C6). In general, companies have the power to induce change and particularly in conflict-prone areas the concept of corporate citizenship suggests companies use their political and diplomatic power to support peace-building. Since the presence of a large company inevitably influences local power distribution, a neutral position in conflict is not possible (Ralph and Hancock, 2018) (C9).

Multi-national companies with corresponding market power

potentially exert pressure on less powerful actors with their RS initiatives. Instead of collaboration, there is more likely to be a boycott of actors who do not meet requirements (Brown et al., 2020). RS, much like fair trade, is a product of Western decision-makers imposing rules and standards on communities in developing nations that are unable to benefit from these initiatives (Hilson et al., 2018). The concerns and needs of Western actors are prioritized, while the local population seems to receive little or no consideration in decision-making processes. This can best be contextualized with the environmental justice discourse on decision-making processes for the approval of new mining operations (e.g., Kojola, 2019). Decision-making processes are designed in a way that participation for marginalized groups is logistically almost impossible, which already leads to an imbalance among the participants. Shared information is often incomprehensible to lay people and the bureaucratic and formal processes favor fact-based arguments over moral and ethical considerations (Kojola, 2019). This means rather than allowing affected communities to decide their own fate, RS still appears to be aimed at appeasing customers' and policy makers' interests and maintaining an SLO, even though the discourse claims to show a shift towards procedural justice such as improved transparency and empowerment of people (Gandhi et al., 2012). A holistic approach to sourcing decisions including bottom-up, multi-actor processes need to become a key element of RS initiatives, since what is considered sustainable for one actor might have negative impacts on the other (Scott et al., 2013, C2).

#### 4.5. Accountability

Accountability is frequently addressed: together with transparency, it is the only NRJ aspect occurring in the different RS narratives. The main discussed aspect revolves around accountability for supplier behavior: discussions stress that suppliers should be responsible for their direct sub-supplier to establish a cascading effect throughout the supply chain (Fontana et al., 2021) (C6). RS is considered one possibility for businesses to reduce their environmental impacts and improve their accountability and traceability (Glass, 2011) (C2). Accountability also plays an important role in satisfying the needs of increasingly conscious and critical consumers: they do not care for cheap or low-priced products (e.g. fast fashion), but place a high value and interest on premium quality and responsibility of products and producers (Dey et al., 2011) (C1, C9). The RS discourse considers transparency as a fundamental prerequisite for achieving this accountability of producers and mitigating supply chain risks (e.g. Kormann and Kicherer, 2015; Lee et al., 2020). Nevertheless, transparency is not the silver bullet to achieve 'hard accountability' which would require more pronounced measures such as sanctions, penalties, compensation and/or remediation in the case of misconduct. These measures reach beyond transparency and require institutional capacity in addition to or driven by public awareness and societal pressure (Fox, 2007) which is a potential challenge for many supplying countries.

In the mineral resource sector, accountability is only indirectly addressed by examining the question of responsibility; currently, this is particularly the case in discussions around managing sustainability in conflict minerals supply chains from the DRC (Diemel and Hilhorst, 2019). Multi-actor efforts are considered a promising governance approach for RS that includes large commercial actors that need to manage their own supply chains and state authorities to provide monitoring and oversight (Diemel and Hilhorst, 2019) (C5, C8). However, limiting the function of governments to monitoring and fixing problems, will not lead to more just markets and supply chains. Governments need to and should be held accountable for directing markets toward fulfilling the needs of society (Mazzucato, 2020). Governmental accountability is particularly a challenge in regions with a notable ASM sector that is embedded in institutionally-weak states with modest and/or fragmented institutional capacity. This can significantly impact the effectiveness of sustainability initiatives, as the case of CSR has already shown (Hilson et al., 2019). This might be, why the results show that accountability

towards the communities affected by extractive operations is considered very modestly compared to (Western) consumer-oriented perspectives.

#### 5. Conclusion

Even though justice aspects have been well established for years in neighboring discourses such as environmental sciences (e.g., Lukasiwicz et al., 2017; Roy and Schaffartzik, 2021; Sowman and Wynberg, 2014), this study confirms that they have not yet found entrance in the RS discourse. Even though, most aspects of NRJ reviewed in this qualitative analysis are addressed in RS literature, considerations of NRJ appear to be very limited and in an immature state. While a holistic account of justice would be required to advance RS to a level of creating equal benefits and value, this link is still missing. The most unexpected result is that the so-called 'resource curse' (Bebbington et al., 2018; Blomfield, 2019) is entirely absent from the whole RS debate, and the authors can only speculate why this is not the case. One explanation could be the apparent focus of RS on securing access to raw materials and reducing reputational repercussions (e.g., Mancini et al., 2021). Considerations regarding the host communities are already limited and most likely do not extend to considerations on the future of communities after the raw material supply has ceased.

While literature suggests that RS is a narrow conceptualization of SSCM exclusively focusing on social issues in upstream supply chains (Young, 2018; Zorzini et al., 2015), our results show that RS covers a much wider area. Even though RS is only part of a very small cluster, it links strongly to many other narratives: covering thematic areas of climate change and circular economy (C1), as well as minerals and metals addressing LCAs, supply chain transparency, governance and due diligence (C1, 5 and 6). Depending on the sector, the focus of RS can shift between the sustainability dimensions to manage the issues that are most apparent in this sector. Since RS is mostly driven by downstream actors, the needs of upstream actors tend to be neglected and the importance of considering the impacts of RS initiatives on suppliers is highlighted (e.g., Mancini et al., 2021; Robins and Kumar, 1999; Scott et al., 2013).

RS literature in the mineral resource sector has been increasing significantly over the past years, specifically in the field of conflict- and transition minerals. While scholarship on mineral resources is certainly also relevant for wind turbine- and solar PV manufacturers, their perspective and possible approaches to RS are virtually absent from the current academic discourse. Only a few papers (e.g., Kramarz et al., 2021; Lundie et al., 2019; Nagle et al., 2022) address the technologies directly, focusing on the recycling, water, and carbon footprint as well as displacements. The perspective of downstream industries is far more advanced in other sectors such as biomass, fashion or retail. Aspects that could be considered more closely in future studies include China's role in and impact on the global mineral resource market as well as the manufacturing and supply of renewable energy technologies. The dominant role played by China in the supply of REE and permanent magnets for wind turbines, polysilicon for solar PV, and their strong expansion into resource markets of the global South needs more consideration in the discourse and future analyses (Kalantzakos, 2020).

The RS discourse also fails to recognize the interaction between social, political, and technological issues, the behavioral changes and critical participation processes needed in cross-sectoral issues such as energy transitions. Rather than considering reactive policies for mitigating impacts and redistributing benefits and burdens, a higher emphasis should be placed on innovation and value creation based on inclusive processes allowing actors to relate, collaborate and share (Mazzucato, 2020). With upcoming legislation on supply chain due diligence by the EU, downstream manufacturers of renewable energy technologies as well as importers of such equipment will be forced to consider their suppliers more carefully, leaving a large potential for research into RS approaches. The results of this study provide ample material for further research on drivers of RS by downstream companies



and how future initiatives can improve to foster NRJ in renewable energy supply chains.

## Author contributions

**Kügerl, Marie-Theres:** Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Writing – original draft, Writing – review & editing. **Hitch, Michael:** Conceptualization; Methodology; Supervision; Writing – review & editing. **Gugerell, Katharina:** Conceptualization; Methodology; Supervision; 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

Data will be made available on request.

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## Appendix A. Supplementary data

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