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Review article

Conflict minerals and battery materials supply chains: A mapping review of responsible sourcing initiatives

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ABSTRACT

Responsible mineral sourcing is a major issue on the global sustainability agenda. Spurred by "conflict minerals", debates about the ethics of mineral supply chains now encompass a broad set of concerns including child labor, corruption, environmental degradation, and a green transition away from fossil fuels. The past two decades have seen a flurry of initiatives to clean up supply chains and protect the reputation of major companies. Based on a mapping review of 220 studies of responsible mineral supply chains, this study highlights the approaches that responsible minerals sourcing initiatives have taken, focusing on conflict minerals (tin, tungsten tantalum and gold) as well as metals and minerals needed for renewable energy technologies in a transition to a low carbon economy (cobalt, graphite, lithium, manganese and nickel). We briefly describe the evolution of these initiatives, contrast arguments about mandatory and voluntary approaches, summarize findings regarding their impacts on local communities and corporate actors, and discuss the challenges and opportunities of new technologies and traceability systems.

1. Introduction

Increasing civil society pressure and customer interest to improve the transparency and sustainability of supply chains has led many extractive companies, manufacturers and retail brands to integrate reputational factors in their strategies to answer the concerns and expectations of clients, investors, and, to a lesser extent, local communities (source). Emerging in their contemporary form out of the 1980s antiapartheid and environmental movements, concerns for 'responsible minerals' and associated initiatives increased among mining companies from the 1990s onwards, with early examples including the Whitehorse Mining Initiative in 1992 and the Global Mining Initiative in 1998. In the Democratic Republic of the Congo (DRC), early work by Fauna and Flora International highlighted the need for companies to address coltan (tantalum ore) mining as a conservation issue (Hayes and Burge 2003). Framed by UN sanctions against 'conflict minerals', including in Angola and Sierra Leone, the inception of Section 1502 of the US 'Dodd-Frank Act' in 2010, seeking to prevent the laundering of 'conflict minerals' originating from the DRC,[1] considerably increased awareness about the need for pro-active minerals responsible sourcing among many corporations involved with electronics consumer products, and more broadly within sustainability debates over supply chains (Sarfaty 2013, 2015; Kim and Davis 2016; Dalla Via and Perego 2018); including as a result of the widespread potential implications of Section 1502 (i.e. all US-listed companies, not only mining ones) and its coverage of several minerals (in contrast to the more narrow if international Kimberley Process Certification Scheme for 'conflict diamonds', see Le Billon 2008; Haufler 2009; Shaik-Peremanov 2014; Van Bockstael 2018; Santiago, 2014).[2] Dodd-Frank's mandatory dimensions also differ from previous initiatives attempting to responsibilize minerals supply chains through mostly voluntary participation and/or compliance (Schiavi and Solomon 2007). The law's intent to hold downstream companies accountable for the

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[1] The 'blood on your hand' slogan even reached the academic writing circles. See for example Veale 2013.

[2] While companies mandated to report are only companies publicly traded in a U.S. stock exchange, the cascading down of requirements increases the number of companies to their suppliers. Hence, while in 2019 only 1,078 filed a conflict mineral report on the Securities and Exchange Commission (SEC)'s website (Deberdt and Jurewicz 2019, 9), the full scope includes all their supplier of 3TG.

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practices of their upstream suppliers represented a significant departure from the previous mining-focused mechanisms. This "governance at a distance" (Young et al., 2018) introduced new challenges, including the ability to engage with 'deep suppliers', defined as "distant lower-tier producers who are positioned at a focal point to mitigate supply chain problems" (Young et al., 2018, 3). The development of (multi)industry organizations governing standards for ethical extraction and trade of mineral resources is inherent to the intended processes of 'cleaning' supply chains from material and reputational risks for downstream and brand companies in contact with final consumers[3] (Fernandes 2018; Young, Fernandes and Wood 2019; Carrigan et al., 2017; Sauer and Hiete 2019).

Fueled by reputational concerns raised by brand companies' customers, the electronics sector spurred the development of responsible minerals standards.[4] The focus on minerals traceability[5] has created an industry around the identification of suppliers in global supply chains, which is then combined with on-the-ground responsible sourcing projects. However, while responsible sourcing standards aim at addressing similar issues around the impacts of industrial or artisanal mining practices on human rights, the environment, and other potential risks, their approach varies greatly.

This mapping review, maps out and categorize existing literature from which to commission further reviews and/or primary research by identifying gaps in research literature (Grant and Booth 2009, 94). The study is based on the analysis of 220 academic, industry, non-profits, and governmental documents identified through Google Scholar, WorldCat and Google searches (see keywords in Section 2). Each document was assessed by reading the abstract and/or introduction. Their selection depends on a clear supply chain component and tangential (i.e. indigenous rights, socio-political reconfiguration of mining communities etc.) topics were not included. We adopted a timeline coinciding with the introduction of the Dodd-Frank Act and its Section 1502 on conflict minerals (tin, tungsten, tantalum, and gold, commonly referred as 3TG) in 2010 up to 2020. The search targeted 3TG and metals used for a low carbon future to reflect the focus of industry. However, a limited number of studies also included other minerals when discussing 3TG and others needed for renewable energy technologies in a transition to a low carbon economy ('green transition metals'); for recent studies comparing the social and environmental economic concerns for these metals and minerals, see (Lèbre et al., 2020; Lee et al., 2020).[6]

Pagell et al. (2010) inscribe responsible sourcing in Sustainable Supply Chain Management (SSCM). They define SSCM as the "manag [ement of] all aspects of the upstream component of the supply chain to maximize triple bottom line performance" (58). In addition to voluntary approaches, mandatory legal systems support the development of comprehensive policies and practices for companies to tackle sourcing risks; even if these mandatory systems – like voluntary ones – do not always translate into responsible sourcing practices as much, as they also reflect compliance strategies by companies and enforcement practices by authorities (Deberdt and Jurewicz 2019; Taka 2014) .[7] Responsible mineral sourcing covers all steps of the minerals supply chains, from upstream (i.e. exploration and mining) to midstream (i.e. processing, refining and transporting) and downstream (i.e. manufacturing and brand companies) actors.[8] In so doing, this study recognizes the full scope of global supply chains, while focusing on its upstream part.

Following this Introduction, Section 2 presents our mapping review methodology, including study selection criteria. Section 3 provides a brief history of responsible minerals sourcing, from supply security to responsible supply. Section 4 summarizes and discusses the findings of studies regarding the adoption, implementation, and impacts of responsible source initiatives. Section 5 concludes and outlines an agenda for further research.

2. Responsible sourcing

Responsible sourcing is integral to many firms' corporate social responsibility (CSR) and constitutes the backbone of due diligence and subsequent engagement with communities along the supply chain (with a frequent focus on communities around extraction sites). As defined by the Organization for Economic Co-operation and Development (OECD) (2018, 15), due diligence "is the process enterprises should carry out to identify, prevent, mitigate and account for how they address these actual and potential adverse impacts in their own operations, their supply chain and other business relationships". While the concept of social responsibility of corporations has been recognized since the 19th century to answer to the harshness of the Industrial Revolution, these efforts focused almost exclusively on the direct relationship between a company and its workers (Smith 2003). The recognition of the role and responsibility of downstream actors in abuses of all sorts in their supply chain appeared generally much later (Guo et al., 2016). In the extractive sector, the boycott of Shell (Rosen 1986), among others, for its investments in the South African Apartheid state led to one of the first instances of what Stolle and Micheletti, 2015 define as "political consumerism". Again, the context of (post)apartheid South Africa provided a very compelling example, with the 1993 sanction lifting exemplifying the role of CSR practices and corporate engagement deep in their supply chains between signatories of the Sullivan Principles[9] and those who rejected any monitoring of their operations in South Africa (Lamb et al., 2005). The responsible minerals sphere increased considerably in the last decades to now include industrial minerals such as 3TG as well as green transition metals.

Responsible minerals sourcing followed the implementation of corporate strategies to tackle a wide array of risks in global brands' supply chains, such as 'sweatshops' in the clothing industry (Spar 2000) and forced labor in the food sector (Nakamura et al. 2018) during the last two decades of the 20th century. The "blood diamond" campaign of late 1990s spurred increasing concerns on the link between minerals

[3] In this article we will adopt a terminology specific to global supply chains, including downstream, midstream and upstream sectors, as well as brand companies. An upstream company is typically an in-country mining operation or raw material processing (also called treatment unit). Midstream actors are companies considered choke points in the supply chains after which traceability is not feasible, namely smelter or refiners (also called SoRs). Downstream companies are all companies using processed material to create products. Finally, brand companies constitute often but not always the end of the supply chain, directly facing individual consumers.

[4] In this article, the terms standards, framework and assurance mechanisms refer to the same categories of tools that allow for the identification of suppliers through auditing. However, more information on the differences between these terms will be provided in the body of this article.

[5] By traceability we intent to discuss the processes by which companies identify their suppliers all the way to the extractive site.

[6] For example, copper, a biproduct of cobalt mining is covered by some of the studies. Similarly, diamonds, while not included in this study are often mentioned in responsible sourcing articles due to the extend to which the KCPS introduced sourcing requirements on producers and supply chain actors.

[7] A counter point to the CSR-washing discourse is provided by Pope and Wæraas (2016). Their findings show that successful CSR-washing is not as rampant as academics, customers or advocacy groups argue.

[8] While we are here interested in responsible sourcing of minerals from extractive sites, it is important to remember that the circular economy raises new challenges regarding responsible sourcing or recycled materials. These cover for example the disposal and waste management as well as the working conditions in facilities processing the minerals.

[9] The Sullivan Principles, developed by Reverend Leon Sullivan in 1977, supported corporate accountability and financial and political pressure on the South African Apartheid regime.

extraction, conflict, and human rights abuses. As the civil war raged in Angola, the National Union for the Total Independence of Angola (UNITA) seized control of an estimated 60 to 70 percent of the diamond production areas (Sherman 2000; Bieri 2010). Pressure from non-profits, especially by London-based Global Witness, led to two U.N. Security Council resolutions requiring certification for diamond exports from Angola (Global Witness 1998). As Bieri argues, this first set of legal instruments aimed at "legitimiz[ing] Angolan diamonds to be sold while sanctioning only UNITA diamonds" (2010, 18) and motivated the first traceability scheme in the minerals sector. By 2003 the United Nations General Assembly supported the Kimberley Process Certification Scheme (KPCS) following recommendations in the Fowler Report. The implementation of the KPCS in Angola, Sierra Leone and Zimbabwe provided the first mineral-specific and downstream led traceability and certification system in conflict-affected and high-risk areas (CAHRAs) .[10] The structure of the KPCS, merging industry-led programs with international import/export controls (Haufler 2010), makes it significantly different than the current trend of state mandated disclosures, corporate due diligence, and on-the-ground programs at the core of responsible minerals sourcing.

In parallel to the 'conflict diamond' campaigns, concerns about a broader range of 'conflict minerals' relating to conflicts in the DRC led to a flurry of responsible supply chains initiatives, some of which sought to secure supply chain for minerals critical to new technologies and green energy transition sectors (Gunn and Bloodworth, 2012; Rosenau-Tornow et al. 2009; Løvik et al., 2018). While initiatives to curtail conflict minerals from financing conflicts in the DRC date back to the late 1990s (see Solvit, 2009), Section 1502 of the Dodd-Frank Act in 2010 acted as a catalyzer for responsible sourcing practices in the minerals sector, and particularly 3TG (Schütte 2019; Ayres 2012; Bleischwitz, Diettrich and Pierdicca 2012; Pickles 2016; Arikan et al. 2015). In parallel, the OECD, with the input of governments, industries and civil society provided the structural integrity of minerals responsible sourcing practices, encapsulated in the Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas (hereafter the OECD Due Diligence Guidance), also endorsed by the U.S. legislation,[11] the Chinese guidelines and the EU Regulation (Liberti 2012; OECD 2016; SEC 2012; Dam de Jong 2015).

The Congolese conflicts, however, have been characterized by dozens of different armed groups and militias as well as abuses by national armed forces (Stearn, Verweijen and Eriksson Baaz 2013), making responsible sourcing practices within an industry dominated by artisanal mining an extremely laborious task for individual companies. While first focused on 3TG, the green transition to a carbon-free economy, and in particular the electric vehicle (EV) development, has increased corporate action on non-conflict minerals responsible sourcing. In 2016, the publication of Amnesty International's first cobalt report placed this mineral at the core of responsible sourcing efforts. Structural to lithium-ion (Li-ion) battery manufacturing, cobalt, of which an estimated 60 to 70 percent is extracted from the DRC, is now the powerhouse of corporate innovation in responsible minerals sourcing. In the past years, interest shifted from exclusively cobalt to battery raw materials, including lithium, manganese, graphite and nickel. Lithium, in particular, has seen an increased focus of the industry in an effort to avoid reputational consequences they faced with cobalt sourcing in the DRC (Stacey 2019). Addressing responsible minerals sourcing should thus not only be conflated with conflict minerals and cobalt. Minerals responsible sourcing is a highly fluctuating field in which reputational and material risks drive innovation. Current concerns around mica extraction in India and Madagascar, lithium operations in the South American lithium triangle and deep-sea mining (DSM) will likely drive responsible sourcing of minerals in the years to come.

3. Methods and data

This mapping review combines a wide geographical and time scope with an effort geared toward completeness. Contrary to other forms of reviews, the mapping review does not include formal quality assessments when defining which documents to select. However, this study allows us to capture the breadth and main characteristics of the literature on responsible minerals sourcing, as well as qualitatively and quantitatively interpret the findings of each documents. Finally, aligned with Sovacool, Axsen and Sorell's argument that reviews should answer to tripartite limitations (Sovacool et al., 2018, 13) of novelty, rigor and style, this mapping review provides an in-depth and novel assessment of a geographically and temporally bounded topic, supported by a strong methodology and communicates the results in a clear and direct manner.

3.1. Studies selection criteria

This mapping review builds on selected studies in the field of responsible sourcing of minerals, with a focus on conflict minerals (3TG) and battery raw materials (cobalt, graphite, lithium, manganese and nickel). The choice of these two categories reflects the current focus of the industry on those minerals in terms of interest in responsible supply chains. As we previously defined it, the responsible sourcing field encompasses social, political, and environmental topics. For this specific review, we center on human-related impacts of minerals sourcing which encompass working conditions at the mines, child labor, involvement of (state and non-state) armed groups, as well as corruption and environmental issues directly impacting communities and social structures.

The mapping review draws from documents published between 2010 and 2020 to reflect the introduction of Section 1502 of the Dodd-Frank Act in 2010. While research on 3TG responsible sourcing is produced since the early 2000s,[12] the U.S. law and its intended and unintended consequences increased academic interest on responsible minerals supply chains. We only examined documents published either in French or English, a choice reflecting the centrality of these two languages for the region at the core of this review: Central Africa and in particular the

[10] The concept of CAHRAs has been first developed by the OECD in its Guidance, long after the adoption of the KCPS. CAHRAs is at the core of current responsible minerals systems and will determine the future of sourcing due diligence, particularly under the EU Regulation 2017/821.

[11] In its final rule, published on November 13th, 2012, the Securities and Exchange Commission (SEC) states that "The OECD's "Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas" satisfies our criteria and may be used as a framework for purposes of satisfying the final rule's requirement that an issuer exercise due diligence in determining the source and chain of custody of its conflict minerals" (2012, 206).

[12] From a non-academic standpoint, see Cuvelier, Jeroen et al. (2002). *Supporting the War Economy in the DRC: European Companies and the Coltan Trade*. Antwerpen: IPIS. From an academic perspective, see Montague, Dana (2002). Stolen Goods: Coltan and Conflict in the Democratic Republic of Congo. *SAIS Review* 22, no. 1: 103-118.

Democratic Republic of the Congo.[13]

Documents were identified through the following search tools: (1) Journal articles and book chapters: search through Google Scholar, WorldCat and UBC Library; (2) Nonacademic reports: search through Google, complemented the existing authors' knowledge of organizations – governments, companies, non-profits, research centers – publishing such documents. Keywords used to identify documents included "responsible minerals sourcing" (and *approvisionnement raisonnable/responsable en minerais*), conflict minerals (and *minerais de conflits*), cobalt mining (and *industrie minière du cobalt*), 3TG, battery minerals, child labor in mining (and *travail des enfants dans l'industrie minière*), lithium mining, manganese mining, graphite mining, nickel mining. Each identified document was then assessed for selection by reading its abstract in the case of journal articles, introduction in the case of book chapter and executive summary in the case of reports. These summaries allowed us to make an informed decision regarding the relevance of the documents and the minerals covered.

Finally, as a mapping review of minerals supply chain sustainability, we excluded studies without a supply chain or sourcing component. For example, studies on the conditions of extraction in artisanal operations in eastern Congo's coltan mines (e.g. Stoop and Verpoorten 2020) or on the social and religious setting in Ghana's gold fields (e.g. Rosen Coyle 2020) were not included despite being linked to the topic of responsible sourcing. Similarly, the growing topic of gender-related topics in artisanal mining[14] (e.g. Danielsen and Hinton 2020; Cuvelier 2014; Huggins et al., 2017) often parallels responsible sourcing concerns but if not clearly stated it was not included in this study. Based on such selection criteria, no monograph was selected for this study, but specific chapters were included.

3.2. Data on selected studies

Our analysis is based on 220 documents, including 102 journal articles (110 in English and 8 in French), 1 academic presentation (French), 18 book chapters (all in English), 5 masters and PhD theses (4 in English and 1 in French), 68 reports (66 in English and 2 in French) ,[15] and 10 industry-specific documents (all in English) .[16] A closer analysis shows that academic articles cover disciplines of law, geography, anthropology, development studies, accounting, business, international relations, and engineering. Being behind pay walls, this knowledge is not easily accessible, especially for researchers and institutions located in the Global South. Looking at the reports, and based on the categories defined previously, the non-profit sector dominates the knowledge production (57 percent), followed by the governments and industry (17 percent each) and the research sector (11 percent).

As mentioned above, while this mapping review focuses on conflict minerals and battery raw materials, many documents explore additional minerals and/or provide information on responsible sourcing at the global level. Table 1, lists the minerals covered by the studies selected in this review, showing that 3TG (jointly as well as individually) and to a lower extent cobalt dominate the sample.

Fig. 1 below provides a detailed description of the date of publication of each types of documents and shows an almost constant increase in the publication of documents on the topic of responsible minerals sourcing from 2010 to 2020. Fig. 2

The extraction of conflict minerals and green transition metals from the Democratic Republic of the Congo (DRC) has spurred a lot of debates regarding responsible minerals sourcing. While in recent years the efforts to clean up supply chains of child labor, poor working conditions, environmental damages, corruption, and armed groups violence reached new geographies, the current academic, governmental, and industrial knowledge production remains centered on the DRC. A bit more than one-third of these studies covers the legal efforts in the Global North – United States (26%) and European Union (10%) – while the majority explore the extractive systems in the DRC (58%).[17] The remaining studies do not focus on specific geographies (global or non-specific) or on other regions, including China, South America and to a lesser extend the Middle East. The diversity of jurisdictions covered by the documents analyzed in this mapping review also translates the broadening of responsible sourcing concerns regarding minerals worldwide.

4. Assessing responsible sourcing

Following our brief overview of issues and characteristics of studies, this section reviews their main findings in terms of adoption, implementation, and impacts.

4.1. Adoption

In 2014, in the aftermath of the first discussions around the introduction of a European legislation on conflict minerals that would mirror the U.S. Section 1502 of the Dodd-Frank Act (for more information on the requirements of the Act, see Sankara et al., 2016), the European Commission estimated that "In the EU […] almost 880,000 companies are trading and processing tin, tantalum, tungsten ores and their metals and gold. These include about 300 EU traders and 19 EU smelters/refiners importing ores and metals, and over 100 manufacturers of components and semi-finished products importing metals" (EU Commission 2014, 19; Gopalan 2017). These numbers underline the widespread use of these minerals and the complexity to establish responsible minerals systems. The level of adoption of responsible sourcing practices varies greatly depending on the space occupied by the companies in the supply chains. Similarly, as materials of interest for downstream users centers around a limited set of minerals, namely 3TG and cobalt, the focus of responsible sourcing systems also differs with the upstream sector. Finally, the concept of responsible sourcing is closely linked to the ability to trace and map supply chains, meaning that we should differentiate between responsible sourcing and responsible production.

The diversity of industries adopting responsible sourcing practices,

[13] As critics of the post-colonial and capitalistic system of extraction, it is critical to note that this choice is also profoundly inscribed in post-colonial concerns regarding the ability for Congolese Swahili, Kikongo, Lingala or Tshiluba speakers to access these materials. In particular, the dominance of English-speaking documents when tackling a topic centered in a French and Swahili-speaking areas of the DRC raises accessibility concerns. From an academic perspective, this reality is worrisome as it highlights the dominance of English-speaking journals and the very limited national audience that these articles may receive. We also fully recognize that this review fuels the exact same concerns. This concerns will be important for future academic and industry research on responsible minerals sourcing in Central Africa and globally. Translation of knowledge production also parallels the establishment and support of higher education institutions in the country with access to these documents.

[14] To understand the growing importance of this field, refer to Volume 54 of the Canadian Journal of African Studies published in 2020 and entirely devoted to the gendering of artisanal and small-scale mining in sub-Saharan Africa.

[15] It is important to note that while the majority of selected reports are in English, these reports are often translated in French. The choice to select the English version aligns with the language adopted to write this review.

[16] While journal articles, book chapters and theses are clearly identifiable, we defined reports to be publicly available, free of charge documents exploring a topic with depth with a stated educational goal. These are released by non-profits, governments, research centers or industry bodies. By opposition, the industry documents on the contrary can be freely accessible but do not hold an objective of public education and focus on the implementation of industry-wide systems for the production of responsible minerals.

[17] The sample covers a total of 23 countries. 26 percent of the studies are also exploring the issue of responsible minerals sourcing from a global perspective without focusing on specific countries or regions.

Table 1
List of minerals covered in the selected studies.

*in light yellow are minerals covered in this mapping review.	Journal Articles	Book Chapters	Thesis	Reports	Industry Documents	Total	Percentage* Based on total of documents, multiple minerals can be mentioned in one document
3TG	71	8	4	16	1	**100**	55%
3T (only)	2	1	0	0	0	**3**	2%
Gold (only)	6	0	0	8	0	**14**	8%
Tantalum/Coltan (only)	4	0	0	0	0	**4**	2%
Cobalt	6	1	0	17	2	**26**	14%
Copper	2	0	0	2	0	**4**	2%
Rare Earths	3	1	0	0	0	**4**	2%
Lithium	1	0	0	3	0	**4**	2%
Cadmium	1	0	0	0	0	**1**	1%
Diamond	7	0	0	5	0	**12**	7%
Silver	1	0	0	0	0	**1**	1%
Colored Gemstones	0	0	0	1	0	**1**	1%
Emerald (only)	1	0	0	0	0	**1**	1%
Jade (only)	0	0	0	2	0	**2**	1%
Ruby (only)	1	0	0	0	0	**1**	1%
Coal	1	0	0	0	0	**1**	1%
Steel	1	0	0	0	0	**1**	1%
Uranium	1	0	0	0	0	**1**	1%
Graphite	0	0	0	3	0	**3**	2%
Manganese	0	0	0	3	0	**3**	2%
Mica	0	0	0	1	1	**2**	1%
Bauxite/Aluminium	0	0	0	1	0	**1**	1%
Sand	0	0	0	1	0	**1**	1%
All	16	5	0	4	4	**27**	15%
N/A	2	1	0	0	0	**3**	2%

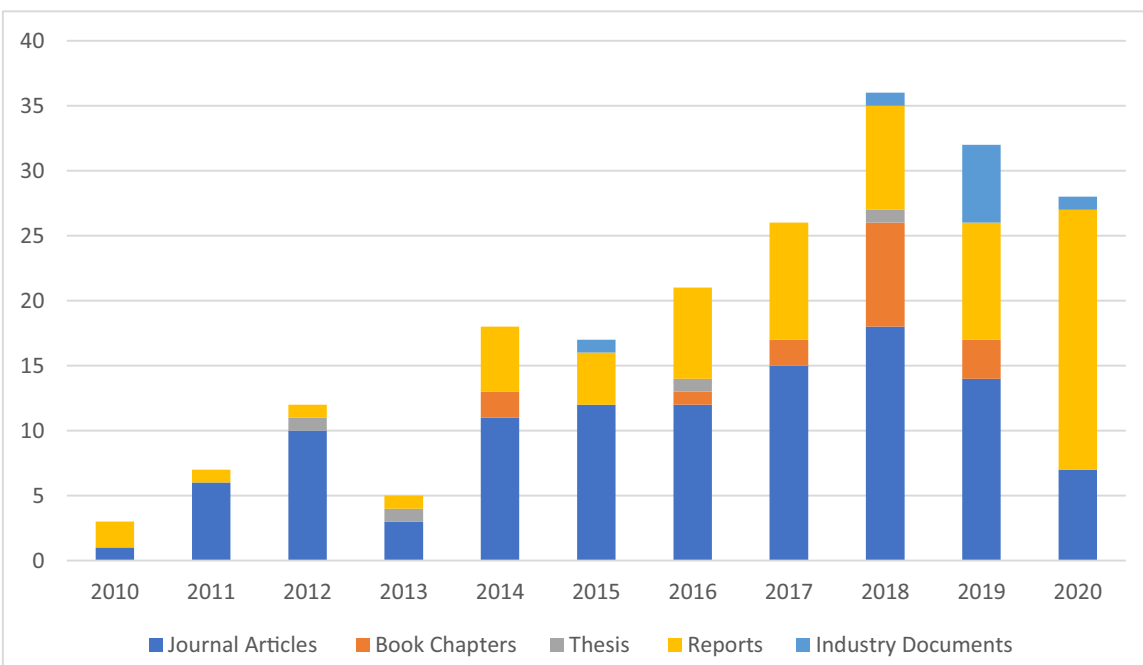

Fig. 1. Years of publication of selected studies.

or under legal frameworks mandating the implementation of due diligence systems shows the prevalence of the use of 3TG and cobalt in everyday products. However, a few sectors have been particularly reactive to these issues, with the technology sector supporting the development of the first responsible sourcing structures (Osburg 2016). According to research by the Responsible Sourcing Network (Deberdt and Jurewicz 2019) and Development International (Bayer and Hudson 2017) the technology sector appears to have embraced minerals responsible sourcing on a more widely basis than any other industrial sector. In parallel, in their study of the automotive sector and the adoption of responsible sourcing practices, Fritz and Tessmann (2018) argue that these structures remain restricted in terms of stakeholder engagement and limited in terms of the scope of sourcing practices implemented. Through interviews and document review, they estimate that the sector only engages with its suppliers, industry groups and the electronic industry, while only traceability concerns and supplier awareness defined the automotive responsible sourcing practices (Ibid., 1). This study highlights some critical points to understand the state of minerals responsible sourcing. First, the electronic sector's dominance, due to its proactive implementation of 3TG due diligence. Second, the

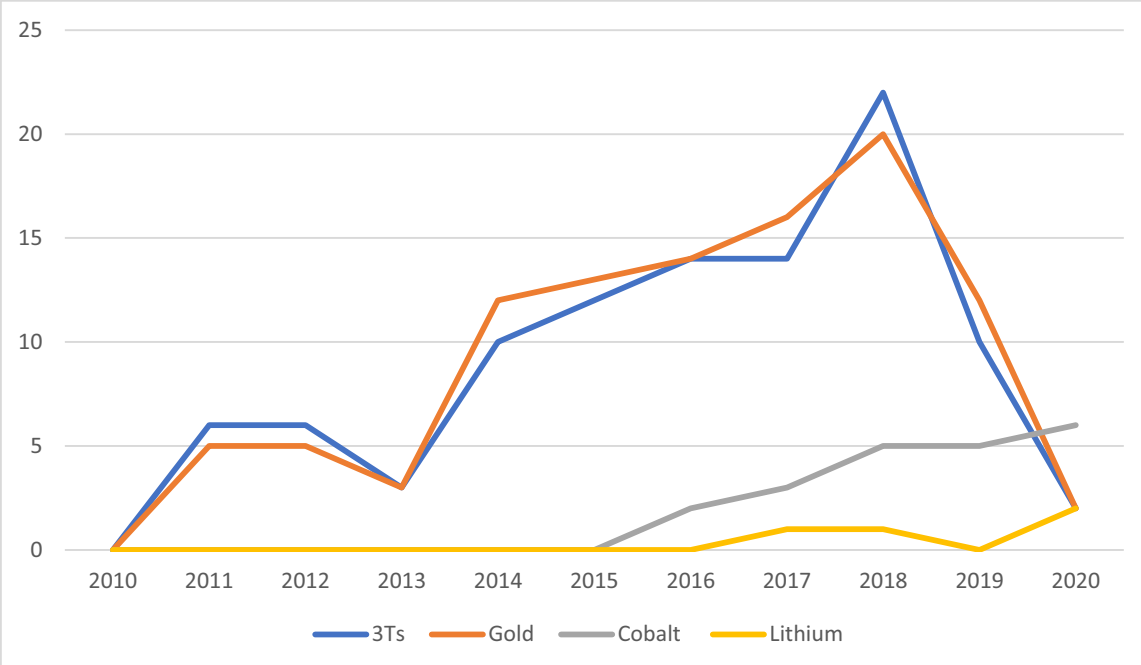

Fig. 2. Publication per minerals (3Ts, gold, cobalt and lithium) per year.

lack of comprehensive systems that not only identify the risks, but also mitigates them. Building on Responsible Sourcing Network's analysis, Dalla Via and Perego explore the implementation of responsible sourcing strategies considering the governance systems in place inside companies. They argue that "[…] in the presence of enforcement leniency, both internal and external firm-specific factors affect strategic (non-) compliance with a mandatory social disclosure regime" (2018, 1). This perspective shows that the adoption of responsible minerals programs, here measured by the quality of Conflict Minerals Reports (CMR) filed at the Securities and Exchange Commission (SEC), varies significantly due to a complex set of factors. Similarly, it remains critical to address the temporality of conflict minerals legislations and the learning curve that led to a decrease in the number of companies filling Specialized Disclosure (SD) Forms and CMR. According to Responsible Sourcing Network, the number of companies filling these documents dropped from 1230 in 2016 to 1078 in 2019 (Deberdt and Jurewicz, 2019). This trend was also noted as early as 2014 when the first round of filings was published, and companies first implemented their compliance programs (Goodman et al. 2014).

In the case of cobalt, van den Brink et al. show through a network analysis the complexity of the global cobalt supply chain structure. They argue that the "analysis shows the important position of companies with high betweenness and degree centrality. A disruption at these companies can affect the functioning of the overall supply chain" (2020, 1). As such the disruption of supply can occur due to sourcing challenges, highlighting the role of responsible sourcing practices. Increasingly, companies focus on new technologies to support their due diligence systems, in particular blockchain-enabled programs. While service providers and companies commit themselves to these new technologies and widely publicize their involvement in these programs (RCS Global 2017, Minespider 2018, Volkswagen 2019) and multi-industry organization increase their support to technology-enabled due diligence (RMI 2020), academic research has shown the limitations of these systems (Grimstad Bang and Johansson 2019). Saberi et al. go even further and argue that "true blockchain-led transformation of business and supply chain is still in progress and in its early stages" (Saberi et al., 2019, 1) and remind us that the implementation of such technology still holds great impacts on stakeholders and supply chain actors. This form of technological traceability is the latest development in responsible mineral sourcing. Previous systems, will being implemented on the ground, have shown the difficulties to implement such systems in an environment such as the eastern DRC or on complex social topics such as child labor. The challenges around implementation will be explored in the remaining of this article.

The issue of the structure of global supply chains is raised by Kim and Davis in a 2016 article that explores the implementation of due diligence systems at the time of the dissolution of vertically integrated industries. As they argue, "Dis-integration [of the supply chains] can reduce costs, but also limits the ability to monitor and control critical processes, including labor practices and the sourcing of supplies" (Kim and Davis 2016, 1). As they analyzed 1300 companies' fillings at the SEC, they found that 80% of them were unable to determine the country of origin of the minerals they source and only 1% "certify themselves conflict-free". While the approach supported by the article can be questioned, especially in the equivocation that conflict-free represents the best outcome possible, it shows that adoption of responsible minerals due diligence systems remains low and potentially on-going. More broadly speaking, the concept of responsible sourcing of minerals is anchored in global frameworks that support its implementation. The OECD Due Diligence Guidance is at the core of the system and provides companies, governments, and any other supply chain actors with a structure to perform due diligence (OECD 2016; Liberti 2012). The Guidance was first released in 2011, covering 3Ts and their derivatives, amended in 2012 to cover gold and is now in its third edition since 2016 (Dam De Jon 2015). It is adhered to by the 37 members of the OECD, as well as nine nonmembers, Argentina, Brazil, Costa Rica, Croatia, Kazakhstan, Morocco, Peru, Romania and Ukraine. As a global document, the Guidance can be applied to all minerals supply chain independent of the type of ore or he geographies in which it is extracted. However, deeply inspired by the 3TG focus in the early 2010s, the document contains two supplements specific to 3Ts and gold, to facilitate identification and mitigation of risks. Today, most of corporate due diligence systems in the minerals field follow the 5-Step framework defined as follows: (1) Strong management systems; (2) Risk identification, (3) Risk mitigation, (4) Auditing; and (5) Public reporting (OECD 2016). In this sense, Liberti defines the Guidance as follows:

"The OECD Due Diligence Guidance offers a common set of intergovernmental recommendations on due diligence, which may constitute a useful reference for national legislative initiatives designed to promote responsible sourcing practices through the implementation of due diligence. This would avoid the risk of exposing enterprises in the supply chain to potentially conflicting requirements depending on the jurisdictions in which they operate" (2012, 43).

In their quantitative study, Silva and Schaltegger (2019) identified the Guidance as the most widely adopted social management structure with reference to conflict minerals. However, while the Guidance provides a strong basis for the establishment of due diligence systems for responsible minerals trade and extraction, standards and frameworks ensure the implementation of these requirements. As such, they constitute the core of responsible sourcing and responsible minerals.

Surprisingly, only a few studies explore the implementation of responsible sourcing practices (Young 2015), and most of them rely on non-profits or think tank data to support their analysis (Dalla Via and Perego 2018). When focusing on minerals sourcing, it appears that most of the studies are interested in the adoption at the downstream level and the possible cascading down of requirements throughout the supply chains, but do not provide in-depth analysis of other supply chain sectors. At the upstream level, global corporate social responsibility assessments are provided by the Responsible Mining Index (RMI) or the Corporate Human Rights Benchmark (CHRB) but unfortunately, they do not focus on the concept of responsible sourcing of minerals and instead tackle social and environmental issues at the companies' operations. This is in part due to the nature of supply chains, and the position of these companies at the end of the raw material supply. Nevertheless, in many cases, it remains important to assess the supply chains of mining companies at their processing plants as inputs might be provided by other industrial operations or artisanal mining (see for example OECD 2019).

4.2. Implementation

Our mapping review confirmed that the implementation of minerals responsible sourcing practices in the 3TG and battery raw materials sector faced significant challenges at every level of the supply chains. Ranging from technical issues regarding the feasibility of due diligence in broad supply chains with hundreds or thousands of actors,[18] to the certification of minerals sourced from so-called responsible sourcing and traceability projects (RCS Global 2019a; Goode 2018; Sarfaty 2015, 450), obstacles to a full implementation are many. However, the current focus of the industry on the topic is also a driver for opportunities to develop new systems of traceability and due diligence that could prove effective in the future.

The impacts of the implementation of responsible minerals sourcing are deeply entrenched with the consequences of legal requirements. The establishment of Section 1502 of the Dodd-Frank Act in 2010 spurred unintended consequences that negatively impacted the efforts to source 3TG responsibly (Seay 2012; Diemel and Hilhorst 2019) .[19] From on-the-ground negative impacts linked to the establishment of a mining ban by then President Kabila leading to the inability for artisanal miners to sell their production on the legal market and the growth of smuggling practices. The decreased economic opportunities in turn led to social and health impacts, including the increase in infant mortality (Parker et al., 2016) and a poor record to decrease the involvement of armed groups in artisanal mines (UN Group of Experts 2020; Stoop et al., 2018). A significant subset of research also tackled the more indirect impacts of Section 1502 of the Dodd Frank Act. These studies question the strategy adopted by the legislator to implement the law through the SEC (Gopalan 2017; Arikan et al., 2017), but also the inherent limitations that a Western-based regulation brings in terms of the reproduction of colonial structures and the lack of on-the-ground understandings (Müller-Koné 2015; Vogel and Raeymaeker 2016).

It is important, however, to differentiate between the limitations of the legal framework supporting responsible minerals sourcing practices and the technical implementation of these programs by companies, non-profits, and governments. Similarly, considering adopting an all-encompassing approach, in which all minerals would face similar challenges seems counterproductive as the geographies, social and political contexts of extraction differ profoundly. Based on our mapping review, we identified five technical limitations to responsible sourcing programs directly linked to the ability of companies to provide on-the-ground responses: (1) scope of the artisanal sector; (2) geographical location facilitating smuggling; (3) ability to access market; (4) integrity of the certification mechanisms; and (5) ability to integrate technology-based solutions. In the following paragraphs we will explore each of these limitations.

The *scope of artisanal mining operations* is a critical point to consider when researching responsible minerals sourcing. Artisanal mining is considered to support the livelihoods of more than 40 million people worldwide (World Bank 2019). In eastern and southeast DRC alone, the International Peace Information Service (IPIS) visited more than 2959 extractive sites as of December 2020 (IPIS 2020). These numbers are largely underestimated as they only cover sites visited by IPIS and the vast majority are concentrated in the three provinces of North and South Kivu and Maniema. As such, the number of artisanal mine sites in the mining powerhouse that represents the former Katanga province is significantly higher. Nevertheless, these numbers reflect the complexity of developing responsible minerals sourcing projects and strategies in these regions. For example, the Capacity Building for Responsible Minerals Trade (CBRMT), funded by the United States Agency for International Development (USAID) has so far only developed projects in a handful of mines in South Kivu (IPIS, 2020) while ITSCI claims to reach 2250 mine sites (ITSCI 2019). The traceability of minerals through complex supply chains involving hundreds to many thousand suppliers proves to be a complex exercise that limits the ability of companies to pinpoint the exact artisanal mine of extraction. These challenges are linked to the other technical limitations we identified, including the geographical location, the ability to access markets and the integrity of certification mechanisms.

Corporate strategies to develop responsible minerals sourcing also face *geographical challenges*, which includes the identification of the origin of minerals and the characteristics of the locations where mining and some downstream activities take place. The current due diligence system, based on the OECD Guidance and the legal requirements (in particular Section 1502 of the Dodd-Frank Act), rests on the ability of companies to identify the country of origins of their minerals. Section 1502 of the Dodd-Frank Act only focuses on nine countries, all bordering the DRC, making it necessary for companies to identify if their minerals are sourced from one of these jurisdictions (US Congress 2010). This preliminary determination must then be confirmed by due diligence to pinpoint the exact origin of the raw materials, including through efforts to carry out mineralogical fingerprinting such as that undertaken by the German geological agency (Melcher et al., 2008). In the same vein, the EU Regulation 2017/821, while implemented at the global level, remains rooted in a geographical identification of risks as it only focuses on regions or countries deemed as Conflict-Affected and High-Risk Areas (CAHRAs) (European Union 2017). Kim and Davis show the inability of companies to identify these countries or regions as 80 percent of the

[18] As an example, Boeing Company supports that to comply with Dodd-Frank Section 1502, the company surveyed more than 12,000 suppliers. See Securities and Exchange Commission (2020). Boeing Co. Conflict Minerals Report. Available from: https://www.sec.gov/Archives/edgar/data/12927/000001292720000052/a201912dec31conflictmineral.htm [Accessed February 9, 2021].

[19] See also the 2013 hearing before the Subcommittee on Monetary Policy and Trade of May 21st, 2013.

almost 1300 companies filling under the Securities and Exchange Commission conflict minerals rule were able to define the origin of their minerals. These findings are corroborated by the U.S. Government Accountability Office (GAO) in its yearly assessment of the implementation of Section 1502 of the Dodd-Frank Act. In its 2020 reports, the GAO highlighted that "half of companies made preliminary determinations of conflict minerals' origin in 2019, but the majority performing required due diligence could not make final determinations of origin" (GAO 2020, 13). Similar conclusions are drawn by non-profits research, including Responsible Sourcing Network's Mining the Disclosures report that measures a 50 percent identification of in-scope determination but marginal identifications of the mine sites (Deberdt and Jurewicz 2019, 16).

The geographical location of artisanal sites, in the DRC but also in many other jurisdictions[20] is a significant factor of risk. The often-remote mining areas, without proper governmental access and representation, as well as the easiness to smuggle minerals challenges corporate ability to develop responsible minerals sourcing. In the DRC, the United Nations Group of Experts estimated in 2020 that from the 1100 kgs of gold produced in the Ituri province, only 73 kgs were officially exported, the remaining sold through smuggling channels in Uganda, Rwanda and Burundi to be later exported mainly in the Gulf (United Nations 2020). This issue was also raised by non-profits working in the sector, including IMPACT with its Just Gold project that argued "It is a high-value, easy-to-transport mineral, making it vulnerable to smuggling and an ideal target for armed groups" (Impact 2019, 6. See also Schütte 2019; Ly 2017). Smuggling practices are also largely found in the cobalt sector but in a very different light. The cobalt "open--market", meaning the unformalized and often considered illegal cobalt artisanal mining production, provides a significant sourcing of raw materials that enter legal supply chains at point of contacts, often in *dépôts* [trading places where the raw ore is stored] (Wakenge 2018). The introduction of these resources in industrial miners feed has been described in many instances (Asshton and Sturmes 2020; OECD 2019) and threatens the integrity of responsible sourcing practices. Swiss trader, Trafigura Group, partnered with Congolese-based but Dubai-owned mining company Chemaf to create the Mutoshi responsible sourcing pilot project[21] and ensure a direct supply of responsibly artisanally mined cobalt to Chemaf's Usoke processing plant in Lubumbashi (Trafigura 2019). Similar projects are being implemented by RCS Global Group-implemented Better Mining (RCS Global 2019a), the Fair Cobalt Alliance (The Impact Facility undated), and a partnership between BMW, BASF, Samsung SDI and Samsung Electronics (BASF 2020).

Another critical limitation to the implementation of responsible sourcing mechanisms is the *ability, of thereof lack of ability, of miners to access global markets* in regulated and attractive terms. In a 2019 report commissioned by the Public-Private Partnership for Responsible Minerals Trade (PPA) addressed the barriers to financial access for responsible minerals trade in the Great Lakes Region (GLR). In particular the report points out structural limitations that disincentivize operators to enter the legal market through high taxes and due diligence costs, and the increased extortion risks by state officials (PPA 2019, 20). This situation and the more welcoming business environment of neighboring countries promotes the smuggling of raw materials outside of the DRC borders. This macro-economic situation is enabled by in-country flaws of the banking systems with no institutions providing the ASM sector with financing access on a sustainable basis. In particular, it appears that the ratio between risk and rewards to engage with the ASM sector in DRC is a significant barrier for local and global banks, and Development Finance Institutions (DFIs) (PPA 2020, 21).

Yet another limitation is the *integrity of the certification mechanisms*. Focusing on supply chain financing of responsible sourcing projects, the Impact Facility highlights the same issue of funding but in a different approach, driven by companies involved in the cobalt trade and transformation. The report argues that "to achieve improvements at the mine level, the responsibility to finance, implement and monitor should be spread along the cobalt supply chain from operators of ASM sites, to manufacturers, and, ultimately, to retail brands" (The Impact Facility 2020, 8). By bypassing traditional financial lenders, new levels of access to finance can be unlocked, but unfortunately these are limited to the 'in-scope' miners, those already part of a responsible sourcing project. This approach also questions the ability of individual miners to independently develop their operations.

The PPA study on the barriers to financial access for responsible sourcing highlights a critical aspect in the absence of benefits that participation on due diligence programs provides for finance access. This question also raises the fourth limitation that we identified, the integrity of certification mechanisms. The current system of 3TG certification centers around two competitors, ITSCI and the Better Sourcing Program (BSP), both aligned with international frameworks such as the OECD Due Diligence Guidance and satisfying industry standards such as the RMI RMAP. In this sense, Tröster and Hiete, 2019 that iTSCi has not "developed [its] own sustainability requirements but relies on and implements the sustainability requirements of the OECD's Due Diligence Guidance" (2019, 9). In the cobalt sphere, the diversification of efforts led to a myriad of projects. However, the OECD Due Diligence Guidance remains the backbone of the industry due diligence systems[22] (Silva and Schaltegger 2019) and provide the structure to the only supply chain oriented standard in the sector, the Responsible Cobalt Initiative (RCI)/Responsible Minerals Initiative (RMI) cobalt refiner due diligence standard (CCCMC 2019). As we will explore later with the establishment of technology solutions to the challenge of responsible sourcing, the integrity of the on-the-ground certification mechanism is critical. In analyzing ITSCI, Postma, Geenen and Partzsch argue that in favor of the cosmetic compliance approach stating that while companies comply with human rights and environmental standards, the on-the-ground effects are minimal. The researchers highlight that these findings result in part from the contamination of certified supply chains by minerals produced outside the monitored sites. Critical to ITSCI, the policy brief recommend in-depth reforms including on the governance of the certification mechanism to act in the public interest and not the industry's, the provision of timely information to stakeholders and finally that monitoring of mine sites should be frequent and in-depth (Postma et al., 2020, 3).

The cost of such monitoring and traceability programs is described as constituting a significant limitation to the implementation of ITSCI and to a lesser extend BSP. In 2014 the cost of ITSCI implementation was estimated to be around 2 to 4 percent of the mineral export value (Cook and Mitchel 2014, 7). In 2019, these costs were estimated between USD130 to USD180 per ton (Reuters 2019). This cost, born by the exporter (i.e. the mining company), has been at the center of

[20] Venezuela is an excellent example of the lack of governmental reach in gold and bauxite artisanal sites and the easiness of smuggling. See Human Rights Watch (2020). Venezuela: Violence Abuses in Illegal Gold Mines. February 4th, 2020. Available from: https://www.hrw.org/news/2020/02/04/venezuela-violent-abuses-illegal-gold-mines [Accessed February 9th, 2021].

[21] Trafigura announced in December 2020 that the Mutoshi Pilot Project will cease. Following the creation of the Entreprise Générale du Cobalt (EGC), a public entity in charge of buying all ASM cobalt production the project was not able to effectively function as a private effort (Trafigura 2020). However, this decision also raises important question as the site will be turned into an industrial mine, with limited employment possibilities for the hundreds of artisanal miners currently on site.

[22] From the RMAP and the RMI/RCI cobalt refiners to the LBMA Good Delivery List or the RJC Code of Practice the OECD Due Diligence Guidance provides the structure and alignment with its requirements is considered a must.

controversies and led in 2019 to the decision by the Société Minière de Bisunzu (SMB), the largest tantalum producer in eastern Congo, to exit the ITSCI system and join BSP (Ibid.). isks facing cobalt mining have led some consultancy companies and service providers to develop new forms of assurance and transparency systems. Blockchain provides the backbone of this up-and-coming trend and is defined as "a system in which transactions are linked together, creating an immutable chain that logs all transactions. This irreversible log is often called the "ledger." Nodes form the infrastructure of the blockchain, so a blockchain exists on nodes" (GovLab and NRGI 2020, 2). Blockchain technology applied to transparency concerns is not new and has been in use in various industries for years. Used in various sectors, from banking (for the banking sector see Guo and Liang 2016; for the fishing industry see Visser and Hanich 2018; for the extractive industry see Hongfang et al., 2019). In the responsible cobalt sector, blockchain applications center around the need to secure information on the conditions of extraction and handling of the raw material and transfer this information to companies all along the supply chain and until the brand user. In other words, blockchain technology allows for information to be shared with different actors while avoiding its corruption. The provision of on-the-ground level information then becomes a mechanism for responsible sourcing that must be combined with capacity-building, training and other development activities.

Blockchain technology is used in the Congolese cobalt industry to store and transmit information through the Distributed Ledger Technology (DLT). The information follows the minerals through its transformation from raw material to hydroxide, sulfate, cathode, and finally batteries. Despite this complex supply chain with hundreds of suppliers, information on child labor, working conditions or any other ASM-related risks is maintained and accessible to the end user (RCS Global 2017).

RCS Global Group implements the Responsible Sourcing Blockchain Network (RSBN) in partnership with car manufacturers Ford Motor, Volvo Group and Volkswagen Group, battery maker LG Chem, refiner Huayou Cobalt and miner Glencore. The RSBN uses IBM's Hyperledger Fabric to secure and transmit information gathered by on-the-ground monitoring of ASM operations around the Lualaba Province's capital, Kolwezi. The program is paralleled with annual audits of its operations while the blockchain system secures the information and transfers it to the company's clients (RCS Global 2019b).

Another service provider, Minespider, originally founded to tackle the issue of conflict minerals, is now applying its technology to other raw commodities, including cobalt. The company is now partnering with automotive giants, including Volkswagen Group to ensure transparency in its minerals supply chains, in particular linked to battery manufacturing. Minespider describes the process as follows:

> "Digital "Certificates" are created at certified mineral sources, such as mines or recyclers, which are then encrypted with the company's public key and posted in a publicly accessible database. As mineral shipments are sold, responsibility data of the new owner is added to the certificate which is re-encrypted with the public key of the new owner, creating a layered encryption like a "Russian doll." This ensures that only the owner is able to access the supply chain data, even though it is in a verifiable, immutable public data store, enabling supply chain transparency without sacrificing data security" (Minespider 2019).

Blockchain in the mining industry was first developed to ensure transparency in the diamond sector (Cartier et al., 2018). Recently, a plethora of initiatives have been spurred by the increased attention to blockchain systems and their potential to securely store and transmit information. Today, the marriage between blockchain and geolocation technologies increase again the reach of this new technological tool and brings potentially significant improvements to global minerals supply chains sustainability and transparency (Bolger 2019).

Nevertheless, complex minerals supply chains, especially in the cobalt sector raise specific challenges (Chohan 2018, 4). The contamination of supply chains considered 'clean' and free of adverse risks by materials extracted in unknown conditions is a significant limitation that only tight in-country control can tackle. While controls can be established, including (i) identity preservation (ii) segregation (iii) mass balance and (iv) certificate trading approaches (Matthew 2020, 14), all rely on the quality of the information gathered. Considering the complexity to access information in conflict-affected and high-risk areas (CAHRAs), the integrity of blockchain-enables systems remains limited. The Natural Resource Governance Institute (NRGI) underlined this when arguing for the combination of technology-based solution to governance and development reforms (NRGI 2020, 8).

4.3. Impacts

Responsible minerals sourcing of conflict minerals or metals critical to the green transition spurred passionate debates on the efficiency and the unintended consequences of imposing requirements on companies to ensure due diligence. In the years following the implementation of Section 1502 of the Dodd-Frank Act, the literature on the unintended consequences of the law targeted both its impacts on Congolese livelihoods and on multinational enterprises (Parker et al., 2016; Seay 2012; Griffin, Lont and Sun 2014; Schwartz and Nelson 2016). However, impacts of responsible minerals sourcing cover a much broader scope. In the last part of this mapping review we provide an overview of the positive and negative consequences of the establishment of responsible sourcing strategies on local miners and their communities, the level of violence in and around mine sites, the economic changes for the countries targeted and the companies required to perform due diligence.

4.3.1. Impacts on mining communities

Diemel and Hillhorst argue that responsible supply chain solutions, especially in the minerals sector are more about "giving buyers a clear conscience…than addressing the root problems that first gave impetus to these initiatives" (2019, 453). This is particularly visible in the 3TG and green transition metals field where initiatives are criticized for their lack of consideration of on-the-ground impacts; from the de-facto embargo that ensued from the introduction of Dodd-Frank Section 1502 (Global Witness 2010) to the local livelihood hardships that resulted from the negative discourse on ASM (Perks and Vlassenroot 2010). Vogel and Raeymaekers found that the introduction of these new requirements "has largely exacerbated dynamics of economic monopolization rather than helping to improve the livelihoods of upstream stakeholders as was discursively intended" (2016, 1115). Economic impacts on communities depending on the sale of minerals products is a critical topic to ensure the sustainability and inclusivity of responsible sourcing efforts. In this sense, and still focusing on the impacts of Dodd-Frank Section 1502, Van Marter highlights that "as we consider the role that consumers play in influencing corporate social responsibility, and the importance of mitigating conflict and poverty globally, Westerners should implement policies that focus more directly on capacity building, internal transparency and governance, and investment" (2015, 312). The notion of capacity building and increased investments in the region's ASM sector is now beginning to be embraced by multi-stakeholder initiatives. In 2020, the Public-Private Partnership for Responsible Minerals (PPA) released a preliminary study on the barriers to financial access for the responsible minerals trade in the Great Lakes region. The research laid down six potential avenues for improvement, which would provide individual miners with improved financial access. Nevertheless, these strategies follow a capitalistic extractive logic,[23] questioning their potential benefits in regions where

[23] For a more up to date analysis of these dynamics, see Le Billon and Spiegel (2021)

these models might not productively answer to miners' needs.

The economic impacts of legal tools appear to trickle down to other sector of the society, in particular health. Studies link decreased health outcomes to the implementation of global due diligence regulations targeting conflict financing and other responsible minerals topics (for example Parker et al., 2016). Arguing in this sense, Parker, Foltz and Elsea support that infant mortality increased in mine sites both intentionally and unintentionally targeted by Dodd-Frank Section 1502. While this analysis provides fertile ground to assess the impacts of such legal requirements, and the authors recognize the possibility of long-term improvements, questions regarding their methodological approach remain. As Koch and Kinsbergen, 2018 describe, the exaggeration of unintended consequences is linked to the studies' inability to shift focus and integrate positive outcomes of the law over time (2018). Similarly, studying the impact of a de facto ban on minerals from the DRC, Seitz supports that "While some critics argue that reporting requirements were tantamount to a ban on minerals from the DRC, I find that stock returns for a subset of companies were sensitive to legislation in the DRC after legislation became law in the US, suggesting that market participants did not expect a complete trade ban on regulated mining and trading activities" (1, 2015).

The lessons learned with the implementation of the US legislation, especially regarding its impacts on Congolese communities, have spurred much debate on the European case. Koch and Bulyuk, 2020 argue that the EU Regulation 2017/821 will likely have fewer and/or different effects than Section 1502 of the Dodd-Frank Act (2020). They draw on a political analysis of the processes in which stakeholders were involved in the definition of the regulation purpose and scope. They support that "one of the misconceptions about unintended consequences is that they are automatically considered unforeseen, unanticipated. Yet, consequences that are not intended by the actor might very well be anticipated" (Ibid, 1458). As the regulation is only implemented since January 2021, it is too soon to yet provide an analysis of its impacts. However, research have shown how the different approach championed by the Block, including the geographically global perspective and the focus on quantities of materials imported, could provide different outcomes for the populations seen as beneficiaries (Cuvelier 2017; Nowrot 2019; Voland and Daly 2018; Schuele 2015).

In parallel to these mandatory responsible minerals sourcing strategies, the green transition metals sector, and in particular cobalt, has seen some slightly different approaches. Commodity trader Trafigura suggested in a study commissioned by the company regarding the Mutoshi Pilot Project and its social impacts that productivity of miners increased (Trafigura 2019). However, the research also shows that in periods of higher global cobalt prices, the average earnings remain below the ASM comparator group while the project was able to slightly mitigate the impacts of the downfall of cobalt prices. However, after the fall in prices, both groups remained at very low-income levels, questioning the real economic efficacy of the project (Trafigura 2019, 20). As Stoop, Verpoorten and van der Windt describe in the case of gold in Eastern Congo (2019), the competition between artisanal and industrial mining is even more acute in the cobalt sector (OECD 2019; Sovacool 2019; ICG 2020; Mancini et al., 2020; Verweijen 2017). It appears that a core weakness of the responsible sourcing efforts, remain the interaction between industrial and artisanal miners, particularly in regard to land rights (Katz Lavigne 2019; Katz-Lavigne, 2020a). In her research Katz-Lavigne argues that "artisanal miners who enter LSM sites in southeastern DRC are viewed in an ambiguous, often negative light […] which situates miners vis-à-vis the presumed "legal" property rights of companies" (Katz-Lavigne, 2020b, 399). In the current responsible sourcing strategies developed by brand companies and their upstream counterparts, this question is often set aside while the focus is on occupational health and safety, child labor and other reputational risks.

4.3.2. Impacts on armed groups, conflicts and violence

The links between mining and violence are well known and the DRC is no exception (see for example Buss 2018; Rustad et al., 2016). Dodd-Frank Section 1502 and the newly implemented EU Regulation 2017/821 predominantly target the issue of conflict financing through the sale of minerals. The definition of CAHRAs answers to this focus and research have at time questioned the positive impacts of the legal requirements while others praised their efforts. Stoop, Verpoorten and van der Brindt found while examining the short term and longer-term impact of the legislation, the law had no positive impacts on violence. They even identified an increase in looting, battles and violence against civilians in comparison to pre-Dodd-Frank levels (2018, 1). Similar conclusions are drawn by Parker and Vadheim arguing that "Instead of reducing violence, the evidence indicates the policy increased the likelihood that armed groups looted civilians and committed violence against them" (2016, 44). In a 2015 article, Sarfaty notes that the issue of security remains a critical topic for the successful implementation of the law. She rightly argues that "Illegal armed groups pose another challenge to efforts to map the region and continuously monitor mines, thus compromising attempts to export conflict-free minerals from those areas" (452).

The limited or even failed success of responsible sourcing effort in regard to security and the involvement of armed groups questions the effectiveness of the laws as humanitarian mechanisms. While we could argue that the US Legislation and the EU Regulation both build on existing mechanisms, such as the OECD Due Diligence Guidance and the Voluntary Principles on Security and Human Rights, and hence increase the visibility of international best practices, changes on the ground are tenuous at best. Militias and the national army are still regularly involved in the extraction and trading of minerals in Eastern Congo, and traceability systems often fail at ensuring a full integrity of the supply chains. On this topic, Postma, Geenen and Partzsch note the need for traceability systems to better integrate four pillars.

> "First, the governance of the certification mechanism should act in the public interest of the regulation in this case enabling a mineral supply chain free of conflict and human rights violations. Second, the certification initiative should provide clear and timely information to all stakeholders. Third, high-quality and frequent monitoring should be ensured. And fourth, there should be a possibility of imposing credible sanctions." (2020, 3)

Nevertheless, the application of these recommendations in a highly volatile security environment appears questionable. The 2019 report of the UN Group of Experts on the Congo reiterates the pervasive involvement of militias, including the Nduma défense du Congo-Rénové (NDC-R), Maï-Maï Yakutumba and Maï-Maï Malaika Sheikh Hassani, as well at the Forces Armées de la République Démocratique du Congo (FARDC) in the 3TG commerce (11–12). Even in cases of mines under the supervision of traceability systems such as the Better Sourcing Program (BSP), security issues have, from time to time, limited the ability to properly monitor these mines (Africa Mining Intelligence 2020).

4.3.3. Impacts on corporate actors

A large body of work has been published on the impacts of such policies on corporate actors themselves in financial, reputational, and decisional terms, and market reaction (Seitz, 2015). The inception of Section 1502 of the Dodd-Frank Act spurred a lot of discussions regarding the cost of implementation of due diligence systems. Schwartz and Nelson quote the SEC in an article, estimating that in the first year the industry would have to spend between $3 and $4 billion to achieve compliance (2016, 1). However, they continue by rejecting this estimate considered as "baseless" and the result of "inapt and unsound economic models" (Ibid, 1). Unsurprisingly, the industry, through the National Association of Manufacturers (NAM), reached implausible cost estimates ranging from $8 to $16 billion (National Association of Manufacturers (NAM) 2011, 2). While the mathematical models used by the NAM were largely flowed (Schwartz and Nelson 2016), the estimated number of

fillers was also largely overestimated at 5994 companies (NAM 2011, 27). Deberdt and Jurewicz showed that the current number of fillers is stagnating around 1200 a year (2019). A similar analysis by Tulane University estimated the cost at around $7.93 billion (Bayer 2011), with no basis, as shown by Schwartz and Nelson and without consideration of the potential economic benefits of the law. In this sense, early in the implementation of the law, Swift et al., 2018, Guilde Jr. and Muthulingam even found that firms with higher visibility in their conflict minerals supply chains performed economically better than those with limited knowledge of their suppliers (2019). Finally, some studies appear to misrepresent the requirements of the law itself. For example, in Jelinek, 2015 estimated that the Big 4 accounting firms (Deloitte, KPMG, EY, and PwC) would generate billions of dollars from the passage of the law, apparently ignoring that the Independent Private Sector Audit (IPSA) only applies for companies certifying that no conflict minerals are in their supply chain. In its 206-company sample, Responsible Sourcing Network's 2019 report only found 4 companies with an IPSA, or 2 percent of the sample (Deberdt and Jurewicz 2019).

While these estimates hide many of the complexities of the law, it remains important to recognize the reach of the requirements. Gopalan states that the US legislation indirectly impacted between 150,000 to 200,000 companies in the European Union (2017, 171). The European Union also estimated in a 2014 impact assessment that the mandatory requirements of the EU Regulation 2017/821 would directly cover more than 300 traders, 100 SoRs and more than 100 manufacturers of finished goods. These would then tickle down to their suppliers, indirectly impacting an important number of companies (EU 2014). The impact assessment also estimated that for large companies the initial cost would be around 0.010 percent of turnover and the recurring cost drop to 0.007 percent of turnover. For small and medium enterprises (SMEs), these costs would higher at 0.154 percent and 0,127 percent respectively (Ibid). To answer to this cost discrepancy between large companies and SMEs, the EU commissioned Levin Sources and RINA Consulting to prepare a report on developing a support system for SMEs targeted by the regulation (2017). The recommendations were implemented by the EU in 2019, through the development of the 'Due Diligence Ready!' portal (EU 2019).

The financial burden on corporate actors is also trumped by the benefits of supply chain due diligence is assessing, identifying, and addressing material risks. Van den Brink et al. address this topic in the cobalt sector by arguing that "the risks for supply chain disruptions are high" (2020, 1). By mapping the upstream supply chain of cobalt, Van den Brink et al. are able to pinpoint specific risks. As they argue:

> "The combination of the geographic map and the network analysis create a comprehensive picture of the upstream cobalt supply chain. This includes information on the company level and geographic level on the diversity of the production, the production of companion minerals (copper or nickel mines) and on the supply of the mineral by risk countries or risk suppliers" (Ibid., 9).

This strategy has been embraced by many downstream consumers of cobalt as they are mapping their supply chains, using auditing systems such as the RMI/RCI standard. In the past few years, companies such as Daimler (2020), Volkswagen Group (RCS Global Group 2020) or Volvo Group (2019) joined traceability and blockchain initiatives, increasing their visibility in their supply chains and potentially identifying weakness points. As Morana, 2017 argues, traceability is "increasingly recognised as a strategic management approach" (2017, 1). While she approaches the issue in managerial terms, we argue that in sectors as volatile as the mining sector, traceability is also a reputational risk management tool. In this respect, some firms are mobilizing blockchain-based processes as a 'technological fix' in order to protect or enhance their reputation (Boersma and Nolan 2020; Calvão and Archer 2021).

5. Conclusion

Why responsible mineral sourcing arose as an international issue; how widely was it adopted; what were the challenges of implementing measures; what were the impacts of these measures? Answering these questions has become critical as more efforts to 'clean' supply chains are under way. As Sarfaty titled her research article, the regulations governing minerals supply chains have "shined light on global supply chains" (2015), allowing for an increased understanding of the structure and impacts of raw commodities sourcing. The extension of the geographical and commodity scope of these efforts have not only led to the inclusion of conflict minerals but also to metals at the core of the green transition currently underway, including through the development of Electric Vehicles (EVs).

Responsible minerals sourcing has evolved significantly since the first models adopted in the oil sector, the diamond and conflict minerals sectors, and now green transition metals. Investments by brand companies directly at the mining level have brought new perspectives in terms of project structure, but also raised questions about the real intentions behind these investments – reputational risk management or sincere corporate social responsibility? Critics have shown on multiple occasions the disconnect between corporate, state actors and the benefits received by the miners. Too often, especially when analyzing the impacts of regulations such as the Dodd-Frank Act, unintended consequences have severely impaired the legitimacy and well-intentionality of the laws.

Nevertheless, it would be wrong to only perceive these voluntary or mandatory measures as negative. While slow, change seems to occur at certain levels of the supply chains and in specific commodities. For example, we can argue that the cobalt sector has come under immense focus from corporate actors (see the numerous responsible projects, development of standards and other industry-led initiatives), non-profits (Resource Matters 2018; Deberdt and Jurewicz 2019; Nyembo et al., 2020, Jean S. J. et al.) and governments (OECD 2019) that spurred very real efforts, such as the creation of responsible sourcing pilot projects, blockchain traceability, and importantly the realization that downstream brand companies need to be involved all the way back up to the mines supplying their materials. The dichotomy between mandatory and voluntary frameworks needs to be explored in much more depth, as is the differences the two leading mandatory systems (i.e. US legislation and the EU regulation) and their impacts on-the-ground. It is also critical for future studies to address the proverbial 'elephant in the room' – the instrumental use of CSR strategies as reputational tools – and to assess the level of investments needed for programs in the responsible minerals sphere to finally become sustainable. This necessitates also the inclusion of local communities to avoid a top-down approach where foreign companies and industries define their objectives in light of customer, investor and non-profit pressure, without addressing the real or imagined beneficiaries, the on-the-ground communities.

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