



Assessing impacts of responsible sourcing initiatives for cobalt: Insights from a case study

Lucia Mancini^a, Nicolas A. Eslava^b, Marzia Traverso^c, Fabrice Mathieux^{a,*}

^a European Commission Joint Research Centre, Via E. Fermi 2749, Ispra VA Italy

^b Afai Consulting BV, the Netherlands

^c Institute of Sustainability in Civil Engineering, RWTH Aachen University, Germany

ARTICLE INFO

Keywords:

Cobalt
Responsible sourcing
Artisanal and Small-scale Mining (ASM)
Democratic Republic of the Congo (DRC)
Social risk
Impact assessment

ABSTRACT

Used in e-mobility and electronics, batteries are key technologies in the decarbonisation of the economy and in accomplishing the aims of the European Green Deal. Cobalt is one of the materials used in lithium-ion batteries, and its extraction is a concern in terms of human rights abuses, child labour, and tragic working conditions particularly in the Democratic Republic of the Congo (DRC) which supplies around 60% of the world's supply, with a relevant share of Artisanal and Small-scale Mining (ASM). Responding to these risks, some programs for the responsible sourcing of cobalt have been launched in recent years. Several policy initiatives at EU level aim to promote ethical sourcing of battery raw materials.

In describing the results of research into the responsible and sustainable sourcing of cobalt for batteries, this article focuses on the artisanal mining sector in the DRC. Based on primary and secondary data collection and assessment of improvement against the requirements of responsible sourcing (RS) frameworks and sustainability assessment guidance (including Social Life Cycle Assessment, S-LCA), this study compares the situation of two pilot projects to the general situation at cobalt ASM sites in the Katangese Copperbelt. Specifically, the study examines the implementation of the Mutoshi Cobalt Pilot (MCP) and Better Mining at the Kasulo site, both in Lualaba province. The case study then provides the basis for discussing the lessons learned for the assessment and monitoring of responsible sourcing programs and of due diligence schemes and possible implications for policy.

Results show that the systems analysed are rather effective in implementing the changes that they are designed to make, especially in the case of life-threatening working conditions, child labour, and corruption. However, the risk categories addressed by these projects are dictated by downstream expectations and do not necessarily correspond to the demands of the miners they are designed to protect. For instance, price calculation and income as well as gender considerations are particularly salient aspects and are not captured by RS programs, but are part of the S-LCA framework. This study confirms the need to support ASM formalisation and its inclusion in global supply chains, discusses the challenges of developing and upscaling RS programs for cobalt, and contributes to the definition of a set of categories to be scrutinized for the assessment and monitoring of these programs.

1. Introduction

Batteries have a crucial role in decarbonizing transport, renewable power generation, provision of electricity to off-grid communities, etc. Consequently, they are key technologies for sustainable development. Demand for them is growing rapidly worldwide and the market for batteries is expected to continue growing at an estimated 25% per year (WEF, 2019).

The demand for cobalt, one of the materials used in lithium-ion

batteries, is expected to increase by a factor of 4 by 2030 compared to current 2020 levels (*ibidem*).

The EU considers that the battery sector is strategic for industrial competitiveness and in achieving the aims of the European Green Deal (EC - European Commission, 2019). The Strategic Action Plan on Batteries was adopted in 2018. This is a comprehensive set of measures to develop an innovative, sustainable, and competitive battery 'ecosystem' in Europe (EC - European Commission, 2018). The European Commission recently proposed a new Battery Regulation with mandatory

* Corresponding author.

E-mail address: fabrice.mathieux@ec.europa.eu (F. Mathieux).

<https://doi.org/10.1016/j.resourpol.2021.102015>

Received 14 October 2020; Received in revised form 12 January 2021; Accepted 3 February 2021

Available online 27 February 2021

0301-4207/© 2021 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

sustainability requirements which include supply chain due diligence for minerals used in batteries (EC - European Commission, 2020). However, responsible sourcing has been high in the EU agenda for many years and the Conflict Mineral Regulation (addressing tin, tungsten, tantalum and gold, 3TG) actually entered into force on January 1, 2021 (European Union, 2017). Furthermore, the Commission has also announced a horizontal initiative on due diligence for 2021 and it is currently in the process of reviewing the Non-Financial Reporting Directive, which requires large EU companies to disclose information on social and environmental impacts.

From studies analysing the material composition of batteries or battery-containing appliances, it emerged that cobalt is a cause for concern in terms of social risks (e.g., Thies et al. (2019) and Drive Sustainability et al. (2018)).

The Democratic Republic of the Congo (DRC) produces approximately 60% of the world's cobalt supply and owns 46% of total reserves and resources (S&P Global Market Intelligence, 2019). Moreover, the DRC is a relevant trading partner for the EU for cobalt ores while refined cobalt is mainly supplied from China. Artisanal and Small-scale Mining (ASM)¹ is a very common form of production in the DRC. What is more, ASM involves various risks in terms of working conditions, exposure to toxic substances (e.g. Banza Lubaba Nkulu et al., 2018; Elenge et al., 2013), illegal presence of armed forces on artisanal sites, the worst forms of child labour, and substantial levels of corruption (BGR, 2019; Mancini et al., 2020; OECD, 2019). The sector is also one of the greatest sources of economic opportunity for millions of Congolese citizens (e.g. de Brier and Jorns, 2020; Zvarivadza, 2018). It is estimated that two million people work as artisanal miners across the country (Delve Database, n. d.).

1.1. Literature review

NGOs and researchers have been reporting serious abuses and other severe social impacts in the DRC mining sectors since at least 2007 (Nordbrand and Bolme, 2007). In 2011 an Öko-Institut study reported violence against women and child labour in artisanal mining sites in the region of cobalt extraction (Tsurukawa et al., 2011). The issue was brought to the attention of the general public in 2016 when the NGO Amnesty International published a report stressing the link between undignified conditions on the ground and the environmental objectives that batteries are supposed to be contributing to (Amnesty International, 2016). Several other reports published since 2016 have addressed the social conditions in artisanal cobalt and copper mines in the DRC (as the two materials are often mined together). Scheele et al. (2016) describes and confirms severe environmental pollution and human rights violations. Findings from surveys of economic wellbeing and health of households as well as the importance of artisanal mining for their livelihoods were published in 2017 (Faber et al., 2017). While this study observes that child labour occurs predominantly in ASM, it also acknowledges that “*disengaging from artisanal mining (reducing demand) can have detrimental effects for a large number of households living in the DRC copper cobalt belt, and while it could decrease the prevalence child labour, it could also increase it due to lowering household incomes*” (ibid, page 3). The role of ASM in sustainable development, as well as related challenges, is also discussed in Zvarivadza (2018), focusing on two case studies in the DRC and Zimbabwe.

Based on desk research and stakeholder consultation, in 2018 The Canadian International Institute for Sustainable Development (IISD) published an analysis of materials needed to enable the transition to a low-carbon economy, describing the real risks of tension and conflict. Recommendations are given to governments, civil society, and private

sectors, which include increasing transparency in supply chains, engaging with local communities in the decision making process, and expanding responsible sourcing beyond 3TG and beyond the DRC to include all minerals required for green energy technologies. (Church and Crawford, 2018).

A recent publication, based on interviews with experts and community members and site visits, investigates the social and environmental implications of the low-carbon transition, taking into account the mining sector in the DRC and the waste management sector in Ghana, conceptualising these processes using the term “decarbonisation divide” (Benjamin K. Sovacool et al., 2020). The study also proposes a set of policy recommendations for improving the sustainability of cobalt mining which includes the acknowledgment of the limitation of traceability schemes and formalisation. The authors warn about the risk that “ethical sourcing” programs are used for greenwashing and cannot improve the ecological and social conditions of communities in the mining areas.

Based on surveys on mining sites in the DRC provinces of Lualaba and Haut-Katanga, the German Federal Institute for Geosciences and Natural Resources (BGR) drew up an inventory of the cobalt-copper sector. Data collected by the surveys concerned the mines modus operandi and the environmental, economic, and social aspects characterising the artisanal mining sites. The study suggests creating incentives for ASM formalisation, creating economically feasible *Zones d'Exploitation Artisanale*² (ZEA), and to applying the Certified Trading Chain (CTC) certification scheme to the artisanal production of copper and cobalt (BGR, 2019). Focusing in the same area, a study by the OECD discusses prevalent risks and strategies for building more responsible mineral supply chains (OECD, 2019). The study is based on qualitative research methods including a review of the literature, desk-based research, remote and field-based semi-structured interviews, and site visits to upstream production and processing facilities in the DRC. Recommendations to DRC government include the extension to cobalt and copper of the existing legal requirements to carry out due diligence as per the OECD Due Diligence Guidance on 3TG. Furthermore, as in the BGR study, the creation of ZEA is one of the suggested measures to strengthen the engagement with ASM. A white paper by the World Economic Forum analyses three project of ASM formalisation in the cobalt producing sites in the DRC (WEF, 2020). While in theory three projects exists, the analysis mainly focuses on the Mutoshi project, which is, according to the study, the most advanced initiative. The aim of this WEF study is not to evaluate the projects, but to derive conclusions on the factors that make ASM formalisation scalable and replicable. The author identifies ten factors, including coordination between project partners, the governance of local cooperatives, agreement on common standard of assessment, and the preparation of basic infrastructure (e.g. preparation of the open pits with heavy machinery, fencing of the site, installation of sanitation services, provision of protective equipment, etc.). The role of cooperatives in the Eastern DRC is also disputed in de Haan and Geenen (2016, 2015). The authors suggest to restructure the governance of cooperatives towards bottom-up and more representative approaches, in order to make sure that ASM formalisation will improve the socio-economic conditions of mining communities.

Other studies investigate specific risks in the artisanal mining sector in the Katanga Copperbelt area or in the Eastern region of the DRC. Some studies have proved health impacts from elevated cobalt exposure in local population (especially in children) and environmental pollution (Banza Lubaba Nkulu et al., 2009, 2018a; Cheyns et al., 2014); birth defects (Van Brusselen et al., 2020), erectile dysfunction associated with metal mining in the Lubumbashi region (Musa Obadia et al., 2020). Some studies explored hazards and occupational health and safety in artisanal mining sites in the Katanga region reporting high frequency of accidents (Elenge et al., 2013; Elenge, 2013) and respiratory health

¹ Artisanal and small-scale mining (ASM), is generally defined as ‘labour-intensive, low-tech mineral exploration and processing activities’ (Hilson, 2011; 1032).

² Zones d'exploitation artisanale; i.e. ASM mining title.

impacts due to lack of protection from ore dust (Kabamba Ngombe et al., 2016).

Other studies describe gender based violence in artisanal mining sites in relation to conflicts and post-conflict transition (Perks, 2011). Rustad et al. (2016), combining survey results with geo-referenced data on ASM sites in the Eastern region of DRC shows that women living in close proximity to ASM are more likely to experience sexual violence. However, the importance of mining as a livelihood for women and their role in the sector is highlighted in Bashwira et al. (2014).

The migration flows to artisanal mining areas, and related gender implications, are for example described in Bashwira and van der Haar (2020) and Cuvelier (2017).

Concerning miners income, a research focusing on 3TG and the Eastern part of the DRC, identifies factors influencing artisanal miners' income (de Brier and Jorns, 2020). In addition to international market prices and seasonality, they include pre-financing, accessibility and remoteness of the mine (which in turn influence the costs of transport), access to phone coverage (allowing to check market prices), the presence of a cooperative (whose influence on income can be both positive and negative), etc. Gender gaps in remuneration are substantial. The report concludes that miners' families have a difficult time to make ends meet. However, ASM remains one of the best income source and the revenues of miners are significantly higher than the DRC rural poverty line.

Sovacool (2019), by extensive field research, depicts the social risks and also benefits (e.g. poverty reduction and development) of the cobalt artisanal mining sector in the Katanga region. The study also proposes seven policy recommendations to improve the sustainability and governance of cobalt mining, which are described in more detail in Sovacool et al. (2020). As in the above-mentioned studies (e.g. OECD 2019; BGR 2019), the authors stress the need for greater coexistence and cooperation between large and small-scale mining operations. Indeed, ASM is much more labour intensive and has a higher impact on local livelihoods than LSM. Therefore, it should not be excluded from the supply chain but regulatory approaches could be found to ensure coexistence between the two forms of production. The need for more transparent supply chains is also highlighted in this study even though it also warns about limitations of current traceability or "ethical minerals" schemes. For instance, building on the experience of initiatives implemented for conflict minerals and diamonds in the past, Sovacool et al. (2020) stress that some of these initiatives can result in additional costs for upstream operators and are ineffective in changing conditions on the ground. In particular, "traceability schemes offer a largely technical solution to profoundly political problems and that these political issues cannot be circumvented or ignored if meaningful solutions for workers are to be found." (Sovacool et al., 2020). Similar critical reflections on the ability of "ethical minerals" schemes to empower the region's artisanal and small-scale miners are also discussed in Hilson et al. (2016). Here the authors argue that designers of these initiatives have poor knowledge of the local context and how to reach the individuals in greatest need of assistance. This study takes account of initiatives implemented for 3TG, diamonds, coal, gemstones and Platinum Group Metals. Responsible sourcing initiatives related to cobalt discussed in the present paper started after the publication of the above mentioned study.

Several other studies assess the impact of legislative initiatives on conflict minerals, i.e., the US Dodd Frank Act³ issued in 2010 (e.g. Cuvelier et al., 2014; Koch and Kinsbergen, 2018) and the recent EU Regulation on Conflict Minerals. The EU project STRADE (Strategic Dialogue on Sustainable Raw Materials for Europe) includes an analysis of the implementation of conflict mineral certification and due diligence schemes with recommendations for the EU (Eslava, 2018): the latter includes undertaking an impact assessment of the conditions these

schemes aim to change.

Some studies, and comments from the European Network on Central Africa (EurAc), highlight the importance of measures accompanying the EU Regulation having positive impacts on the ground and support artisanal miners (Cuvelier, 2017b; EurAc, 2017; EurAc et al., 2019).

1.2. Objective of the study

As described above, many lessons can be extracted from the literature on the impact of conflict minerals initiatives and other ethical mineral schemes. However, to the knowledge of the authors, recent responsible sourcing programs on cobalt have hardly been addressed in literature. The aim of this paper is to fill-in this research gap by addressing the following research questions:

- What are the impacts on workers and local communities of the few pilot projects on responsible cobalt implemented in the DRC?
- What lessons can be learned for the assessment and monitoring of RS programs and of due diligence schemes, in particular in a policy context?

2. Methodology

2.1. Selection of initiatives

When this research started in mid-2019, only two initiatives in cobalt artisanal mining areas in the DRC had been implemented for at least one year: *Better Mining* and *Mutoshi Cobalt Pilot Project* and they were therefore selected for this study. They are described in the following section and the map below shows their location (Fig. 1).

2.1.1. Better mining

This program was promoted by the audit and consulting group RCS Global Group together with the Coopérative Minière Kupanga (COMIKU) and Congo Dongfang International Mining (CDM). Launched in June 2018 with the pilot phase in the Kasulo artisanal mining area, Better Mining is a site monitoring solution that generates monthly incident reports and corrective action plans (CAP) for its implementer. Full implementation was started in January 2019. The program focuses on information collection followed by CAP preparation and dissemination. It does not provide any form of traceability: the information it provides characterises the site and not the material. The implementation of Better Mining is entirely financed by the operators using it, i.e. CDM. The information collected concerns incidents, risks, and relevant contextual information (e.g. price of cobalt outside the site). Risks and incidents are based on the Better Sourcing Program Standard v6 (2016), a standard that is based on the OECD Guidance (BSR, 2016). The information is collected by site-based trained staff equipped with a dedicated app on their smartphone. Once the information has been collected, it is analysed by the RCS Global Group staff, who then identify underlying systematic causes and issue the CAPs. Better Mining does not implement any of the corrective measures from the CAPs, but monitors the implementation of the CAPs. In addition to the monthly incident report and CAPs, the implementer receives an immediate alert for high-risk incidents.

Access to the site is now only possible through dedicated doors, which are under supervision at all times. In order to enter, miners have to provide a document certifying that they are over 18 years old. According to COMIKU, there are 1300 miners working on site, all male, while 20 women work on three dedicated washing basins. These basins are filled with water and, once silted and dry, the tailings are removed. This avoids the washing of ores directly into the river, which previously took place. The washing basins are then refilled. Part of the site has benefited from overburden removal, which has targeted the areas considered to be at highest risk.

³ U.S. Congress (2010) Dodd-Frank Wall Street Reform and Consumer Protection Act. Section 1502 Conflict minerals.

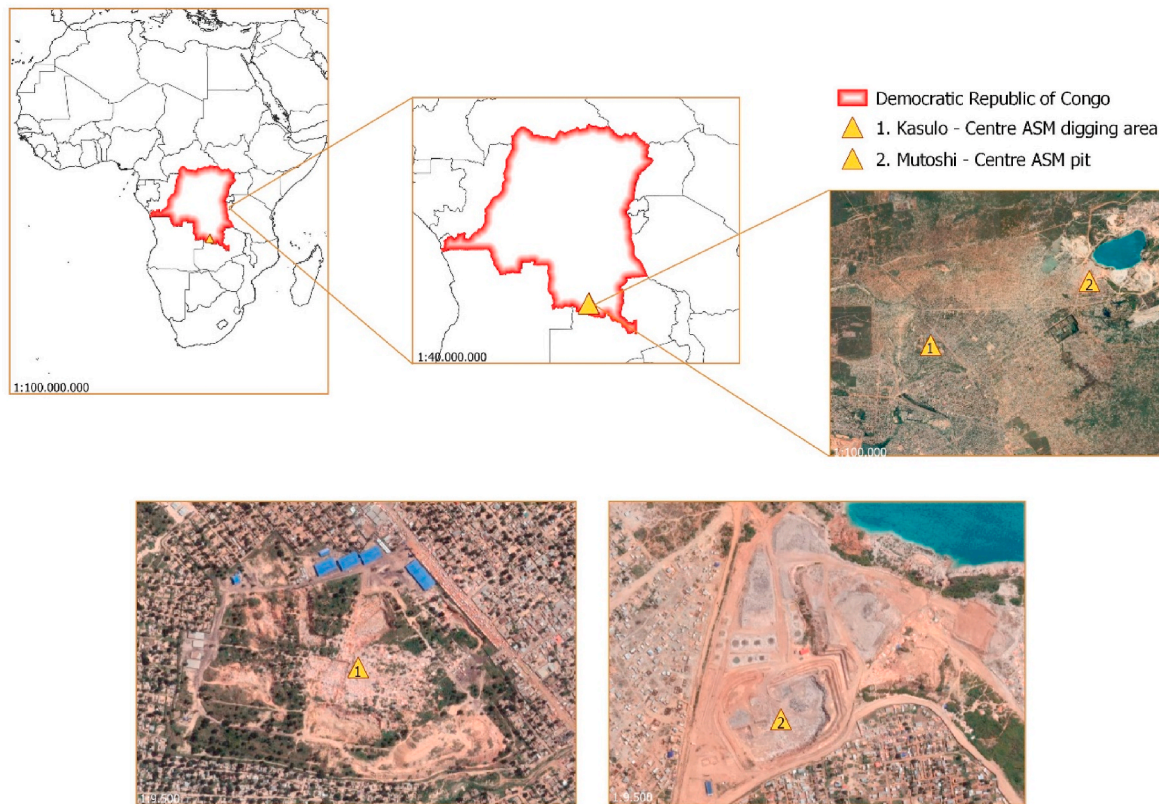


Fig. 1. Map showing the location of the two programs under investigation.

2.1.2. Mutoshi Cobalt Pilot project

The Mutoshi Cobalt Pilot (MCP) is a partnership between the Trafifigura Group (a commodities trading and logistics company), Chemaf (a mining company), COMIAKOL (a cooperative for artisanal and small-scale mining), and Pact (an international NGO). The pilot project aims to improve safe working conditions by site monitoring and reporting information on incidents, by improving technical knowledge of ASM and of downstream demands, by enhancing community outreach, and by raising hazard awareness and safety management capacity amongst ASM miners.

The pilot, implemented in the Mutoshi concession in April 2018, is located on an area previously developed as an informal ASM site where many deep tunnels, some of them more than 50 m deep, were present. The pilot site is now divided into an extraction area, two washing areas, a temporary storage area, and a tailings area. The entire pilot area cannot be accessed by the community, and the miners enter through designated gates by showing their membership cards. An official listing of prices for cobalt and for various mineral grades is shown at the buying centre in US dollars per tonne of material. In addition to their membership cards, miners have to wear personal protective equipment (PPE) and closed shoes to enter the site. Overalls and hard hats are offered free of charge to the members. Some members also use gloves or rubber boots depending on their tasks.

At the time of the visit, COMIAKOL had 4083 registered miners, 142 registered washers, 364 male mineral buyers, 228 female mineral buyers, and 98 mobiles (cooperative members in charge of overseeing the site). Overburden had been cleared from the extraction area, making

the deposit immediately accessible to the miners. The miners must limit the depth of their excavations to 6 m and strictly proceed vertically as pits must not branch into tunnels. Compliance with these rules is monitored by a combination of SAEMAPE (*Service d'Appui à l'Exploitation Minière Artisanale et à Petite Échelle*), agents, and mobiles. Once a sufficient number of pits have reached their maximum depth, the site is once again levelled out by machinery and the cycle is restart.

2.2. Selection of standards

According to van den Brink et al. (2020) there are two main approaches to managing responsible sourcing of minerals: supply chain due diligence, and sourcing via sustainability schemes (Fig. 2).

Concerning the due diligence approach, the main reference is the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas v3 (referred to from now onwards as the OECD Guidance) (OECD, 2016), a government-backed multi-stakeholder initiative for responsible supply chain management. The OECD Guidance has become the underlying standard of a significant number of mineral certification schemes and audits as well as a number of companies' corporate policies regarding mineral sourcing from conflict or high-risk areas (CAHRAs). It is also the guidance underpinning the EU Conflict Minerals Regulation (EU CMR).

The China Chamber of Commerce of Metals, Minerals & Chemicals Importers and Exporters' (CCCMC) Due Diligence Guidelines for Responsible Mineral Supply Chains (CCCMC Guidance) also provides a set of minimum standards and guidelines to support company efforts in

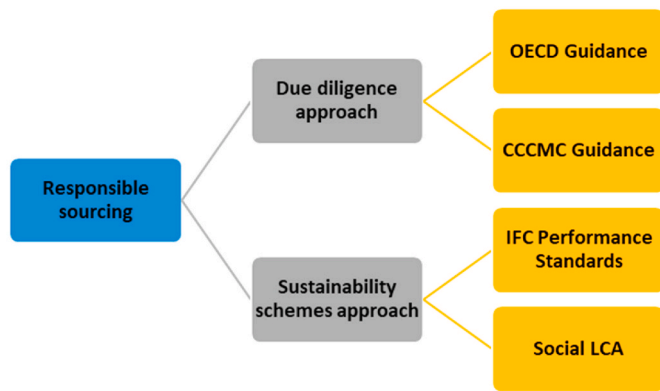


Fig. 2. Standards selected for comparison of requirements.

identifying, preventing, and mitigating the risks of directly or indirectly contributing to conflict or human rights abuses. The CCCMC Guidance also includes issues relating to indigenous rights, pollution, and biodiversity conservation, among others. This standard was also selected for the analysis presented in this paper as it is a standard for Chinese companies which operate widely in the mining sector in the Katanga region.⁴

Several frameworks exist in the area of sustainability schemes.

The International Finance Corporation’s (IFC) Performance Standards (PS) are the part of the IFC’s Sustainability Framework directed towards its clients. The IFC, a sister organisation of the World Bank and member of the World Bank Group, is the largest global development institution focused on the private sector in developing countries. Given the subject of the analysis presented in this paper, i.e. the sector of artisanal mining in the DRC, it is considered that this as an appropriate tool for the evaluation of the initiatives’ impacts. The IFC PS provide guidance on how to identify risks and impacts, and is designed to help avoid, mitigate, and manage risks and impacts as a way of doing business sustainably.

In addition to the IFC PS, the impact categories used in Social Life Cycle Assessment (S-LCA) have been added in the analysis. S-LCA is an impact assessment technique used to assess the positive and negative social impacts of goods and services through their life cycle (UNEP/-SETAC Life Cycle Initiative, 2009; UNEP, 2020). This approach avoids the shifting of burdens between geographical areas or supply chain steps when evaluating impacts. Moreover, the wide spectrum of impact categories and related stakeholders (as recommended by the Guidelines published by UNEP/SETAC Life Cycle Initiative in 2009) includes additional aspects that are not included in the responsible sourcing schemes.

2.3. Selection of impact/risk categories and development of information matrices

The selected standards and frameworks put forward different lists of risks/impact categories to be checked in a due diligence process or in an impact assessment. In the case of S-LCA, impact subcategories are listed for a set of potential stakeholders.

The lists of risks under the OECD Guidance and CCCMC Guidance as well as the aims of the IFC PSs have been extracted and compared in order to ensure consistency and avoid any unnecessary overlap. Starting with the OECD list of risks, the additional categories from CCCMC and IFC (i.e. not included in the OECD framework) were added and a list of information to collect was compiled.

⁴ For instance, the Congo Dongfang International Mining (CDM) is a subsidiary of the Chinese Huayou Cobalt Co., Ltd.

Table 1

List of categories used for the assessment and additional S-LCA impact subcategories, for the two stakeholder selected.

Standard/framework	Impact/risk category	
A. OECD Guidance	A.1 Serious abuses associated with the extraction, transport or trade of minerals A.2 Direct or indirect support to non-state armed groups A.3 Public or private security forces A.4 Bribery and fraudulent misrepresentation of the origin of minerals A.5 Money laundering A.6 Payment of taxes, fees and royalties due to governments	
B. IFC Performance Standard	B.1 Assessment and Management of Environmental and Social Risks and Impacts B.2 Labour and Working Conditions B.3 Resource Efficiency and Pollution Prevention B.4 Community Health, Safety, and Security B.5 Cultural Heritage	
C. CCCMC Guidance	C.1 Type 2 risks NOT covered by OECD Guidance or IFC PSs	
Additional S-LCA impact subcategories	Local Community	Health & Safety Local employment and economy Social benefits/losses Cultural heritage & land rights Discrimination Forced migration/resettlement and land rights Poverty
	Workers	Health and social well-being Wages Social benefits Working conditions Discrimination Freedom of association and collective bargaining Training and education Job satisfaction and engagement

Consideration is given to the ASM context and the applicability of each element, particularly in the case of the IFC PSs. Indeed, in certain cases the requirements of the standard targeting LSM are not applicable to the capacity of ASM operations. The decision to include or exclude an element is justified in the supplementary information (sheet 2).

The list of aspects included in the S-LCA framework has been analysed separately according to the S-LCA Guidelines ((UNEP/SETAC Life Cycle Initiative, 2009). These guidelines suggest five main stakeholder categories but only two of them have been selected: workers and local communities. Table 1 lists all of the risk categories taken into account in the study while the full list of indicators used for the characterisation and the justifications for exclusion can be found in the supplementary information.

These information lists were complemented by the drawing up of a list of contextual information to collect.

The finalised information matrix, including the information to be collected in the four frameworks and also the contextual information was then used to structure the field data collection. Information matrices are interview guides (i.e. a list of topics to be covered and questions) used in semi-structured interviews and have been developed starting from the definition of specific research questions and interview questions (e.g. Bryman (2016); Kallio et al. (2016)). Research questions are based on the requirements previously selected from the frameworks and help understand whether a certain risk has occurred. For instance, in order to determine whether there is a risk of serious abuse associated with the extraction, transport, or trade of minerals (first risk in the OECD

Annex 2), a list of 21 questions was developed including, e.g., whether miners are obliged to purchase goods or their IDs are kept on site (see supplementary files for the full list). Semi-structured interviews were chosen as a replacement for questionnaires as a significant part of the supply chain remains non-formal (either illegal, informal, outside of applicable legal norms, or where regulations are applied selectively as a rule). In such a context, stakeholders generally respond to structured questionnaires poorly, which are too thorough and too often make stakeholder confront their non-formality, which does not help establish the interpersonal trust necessary to obtain information about non-formal activities.

2.4. Development of a baseline scenario and field data collection

In order to have a term of comparison for the assessment, a baseline scenario was developed where no initiatives are in place. It consists of a combination of literature and primary data to represent the starting point or in other words the ASM scenario without initiative. This is a common practice in S-LCA because, unlike in an environmental assessment, where less emissions are always better, social improvements are not always easy to define (Jørgensen et al., 2010). In S-LCA, defining a referencing scenario can be done using the targets to be achieved or building a baseline scenario (or scenario zero) where no actions have still been done (UNEP, 2020). In both cases, guaranteeing transparency in presenting the values of those scenarios is a priority for the study and its repeatability. Indeed, having the study started when the initiatives had already been implemented, data on the ex-ante situation was not available. From a methodological point of view, a baseline was created and then it was compared to the current situation on the sites instead of asking a wide range of stakeholders for their opinion. Indeed, using an approach based only on interviews, the data collected would be based on the perception of salient issues by actors and only the issues considered the most important would have been recalled in enough detail.

The scenario was intended to represent the general conditions of the ASM sector in the region and was based on:

- Literature review: mainly BGR (2019) and OECD (2019) and for more specific issues Amnesty International (2016) Callaway (2018); Faber et al. (2017).
- Interviews with stakeholders (as stated below and in the supplementary information).
- Visit of one site⁵ that CSO representatives confirmed was broadly representative of a generic ASM site.

These sources were complemented by prior knowledge that one of the authors had acquired during three projects in cobalt-copper supply chains in the Copperbelt between 2016 and 2017 when no initiative have taken into place yet.

The characterisation of pilot sites and of the cobalt-copper (2C) ASM sector is based on information collected through both primary and secondary sources, phone interviews, in-person interviews, and direct observation in and around mine-sites. Interviews have been conducted over the phone and in person with a diverse range of stakeholders, covering the categories of workers and local communities, which have been considered the most relevant one from those proposed in the S-LCA Guidelines (UNEP/SETAC Life Cycle Initiative, 2009). The categories of workers included:

- initiative implementers (3),
- ex-child workers from neighbouring communities (15),
- ASM miners from the pilot sites as well as ASM miners' representatives (6)

The category of local communities was covered including:

- representatives from CSOs (10),
- community representatives (12)

Moreover, we expanded the survey to other "neutral" actors like subject matter experts and representatives not affiliated to a CSO (5), and representative of government agencies (2).

In-country work was undertaken in Lubumbashi and Kolwezi between September 30th and October 8th, 2019.

Furthermore, visits to the two pilot sites were conducted under the guidance of multiple representatives of the initiative implementers, the operators, the SAEMAPE (*Service d'Appui à l'Exploitation Minière Artisanale et à Petite Échelle*) agents deployed, and the assigned cooperatives (13 or 14 people in total depending on the pilot site). Due to the heavy presence of officials, ASM miner were interviewed at a different time, in a neutral location, and in small focus groups in order to grant them anonymity and to allow people to respond to each other's views. Representatives of organisations were interviewed individually.

This information gathering was complemented by a visit to a third ASM site where no pilot was implemented (see description of baseline scenario above). This site was chosen as being representative of the general 2C ASM sector in terms of: extraction methods, performance in regards to the requirements of the OECD Guidance, formality and organisational structure according to a wide cross-section of consulted stakeholders.

2.5. Characterisation of mining sites

The list of aspects and risks selected for the development of information matrices (listed in Table 1, section 2.3) was summarised and translated into 14 categories of risks to be characterised based on the information collected in the interviews, observations, etc. (the matching between the list of information and the risk categories is in the supplementary files). The qualitative information collected is translated by the characterisation into an evaluation of the level of improvement or deterioration of the situation where the initiative is implemented compared to the baseline scenario. Raw data, i.e., the qualitative information collected for each aspect in the information matrix is available in the supplementary materials.

Given that neither Better Mining nor the Mutoshi pilot operate in a vacuum or only by themselves, the level of influence of the programs was also assessed. Indeed, both approaches are part of broader initiatives implemented on site and coordinate their work with the mining operator, the miners, the cooperatives, the state agencies, and, in the case of Mutoshi, the initiative's financier. This has significant implications when it comes to assessing the impacts of these programs individually and not as part of the broader initiatives they are a part of. In order to discriminate, together with the assessment of improvement/deterioration, the results state the level of influence of the system (or program) as being direct or indirect (i.e. through the initiative).

3. Results

The results of the assessment for each impact category are presented below. A concise evaluation is provided at the end of the chapter (Table 2).

⁵ For reasons of confidentiality, the location of the baseline site cannot be disclosed.

3.1. Evaluation across the 14 risk categories

3.1.1. Presence of armed groups

The presence of non-state armed groups is not an issue in the Haut Katanga and Lualaba region, and this was also the case in the sites under investigation, along transport routes, and at trading points.

3.1.2. Presence of armed forces

Compared to the baseline, where non-authorized armed forces are observed at the mining site and at checkpoints, the inappropriate presence of state armed forces is much lower in the Kasulo and Mutoshi sites. Neither of the sites had the FARDC (DRC Army) present or the National Police, GR (Republican Guard), or any armed forces different from the PMH (*Police des Mines et Hydrocarbures*). In Mutoshi, as in any ASM site in the region, the ANR (*Agence nationale de renseignement*, DRC Intelligence Agency) is rumoured to have agents on the pilot site. In Kasulo the *Division des Mines* shares its offices with the “renseignement” (intelligence services) as written on a plaque by the entrance to the office. This was confirmed by local staff. It is understood from interviews with miners that the intelligence services present on site include ANR, DEMIAP (*Direction Militaire des Activités Anti-Patrie*), and Bureau 2. However, this could not be confirmed. While the issue of the presence of intelligence agencies on ASM sites is less clear-cut than in the case of armed forces, the presence of agencies noted for their negative human rights record is nevertheless cause for concern.

3.1.3. Serious human rights violations

Human rights violations are a serious risk in the 2C ASM sector but none have been directly observed on the pilot sites. However, protests in the Kasulo neighbourhood adjacent to the site and triggered by the ASM activity on site⁶ turned violent and led to the intervention of armed forces not stationed on site. This intervention resulted in four fatalities, two of them not miners according to CSO reporting.⁷

Both pilots ensure the absence of non-authorized miners in their operations by having fencing/walling, therefore reducing the opportunities for confrontation between armed forces or private security present on site and ASM miners. At the same time, according to the staff interviewed neither of the sites had either security or PMH agents trained on the Voluntary Principles on Security and Human Rights (VPS) or International Code of Conduct for security Providers (ICoC). In both cases, the contract is not established at the pilot level and so there is a lack of clarity on site as to the rationale behind the selection of any particular firm or their human rights track record.

3.1.4. Forced labour

Compared to the baseline, where risk of forced labour can be considered to be minimal under current circumstances, there is no change in regard to the presence of forced labour on sites, along transport routes, or at trading points.

3.1.5. Worst forms of child labour

In contrast to the baseline, where child labour is a serious risk, no cases of child labour or of young adolescents working on sites has been either directly observed or reported by the CSOs or miners consulted. Both pilot sites seem to rigorously enforce age control systems in order to avoid the presence of minors on site. Issues of child labour

⁶ The exact cause of protest could not be determined at the time of writing. According to COMIKU and CDM staff in Kasulo the protests were initiated by miners not working on site and protesting against entry requirements while CSO representatives attribute it to dissatisfaction of Kasulo miners with prices and mineral contents (i.e. perceived incorrect determination of cobalt content) offered on site.

⁷ ONG Espoir, 2019, Des morts dans les événements de Kasulo à Kolwezi. Released on 03.07.

(handpicking) on Chemaf’s title have been mentioned by local community children but are not connected to the pilot. While the pilots are effective in avoiding child labour, it is not possible to know whether on a broader scale child labour on mining sites has been reduced at regional level. Indeed, if pilots are small islands surrounded by “business as usual” mining sites, children might just move from the pilot areas to other uncontrolled sites. This, however, goes beyond the scope of this investigation and the elimination of the worst forms of child labour at regional and national level requires policy measures such as access to completely free and quality education and reduction of extreme poverty.

3.1.6. Corruption and bribery

According to the miners consulted, unlike for the baseline extortion payments or the payment of owed services (such as the services of SAEMAPE) by the miners is reported to be minimal if non-existent on these sites. The granting of the mining title for both Kasulo and MCP was managed by the respective companies and not by the pilot. This issue is therefore not considered in this analysis. On the contrary, extra-legal payment are frequent in the 2C ASM sector according to BGR (2019) and as reported by stakeholders.

3.1.7. Misdeclaration of origin of minerals

Compared to the baseline, the potential issue of misdeclaration of mineral origin is somewhat more complex.

In Kasulo, minerals from outside cannot enter the site without the willing participation of staff and the entire production of the walled off area is legitimate as it originates from within the ZEA. Neither CSOs nor miners mentioned that any mineral production enters from outside the site. However, it should be noted that Congo Dongfang International Mining (CDM) does buy minerals from other sites. In particular, it purchases ASM copper material (which contains some cobalt) which casts a wide net. Therefore, any claims that CDM production is responsibly sourced would have to be treated with caution as no assurance regarding the conditions of extraction of material that is not from Kasulo or a similarly monitored site can be given. Furthermore, it has to be highlighted that Better Mining does not provide any traceability of materials.

Regarding the Chemaf buying centre located within the Mutoshi title, all stakeholders have mentioned that.

Chemaf’s buying station buys ASM minerals regardless of their origin, and this was also directly observed during site visits.

ASM miners and community members consulted have all declared that no material can exit the Chemaf title. Anyone caught trying to smuggle material out of the title has his production confiscated and faces a likely beating. Note that this applies to the title and not the pilot site.

In summary, issues of misdeclaration of mineral origin are currently not an issue as neither operator makes claims about the product they sell. On the other hand, claims are focused on the implementation of initiatives. Issues could potentially emerge if operators start making claims about the characteristics of the specific material they supply, and do so without fully guaranteeing that these claims are associated with the specific atoms in the material they are selling to their clients.

3.1.8. Payment of taxes

It was not possible to find out whether taxes have been paid as tax information and the contracts that underpin specific tax arrangements are commercially sensitive. Moreover, the payment of taxes would refer to the whole company and not to the pilots.

However, although not confirmed, these being formal operations, it is extremely likely that the pilots pay at least a certain amount in taxes.

3.1.9. Displacement and resettlement

As in the baseline, there is no noted risk₇ of displacement, or resettlement as both systems are implemented on existing sites. The site of Kasulo has experienced issues of displacement in the past but these issues predate the implementation of the Better Mining pilot. Issues of resettlement on Chemaf's title in Mutoshi have been mentioned by local community members but are not connected to the pilot.

3.1.10. Occupational health and safety

Compared to the baseline, the occupational health and safety (OHS) conditions on both sites are significantly better as neither has recorded any fatalities during the last year and the level of risk has decreased markedly according to both miners and consulted CSOs. While it is too early to draw conclusions at this stage, this could be attributable to either a complete removal of overburden in the case of Mutoshi or to the combination of risk based localised overburden removal with additional SAEMAPE monitoring in the case of Kasulo.

It is also likely that the long-term impacts of washing activities (urinary tract infections and other gynaecological complications) will decrease or disappear as precautionary measures (shallow washing ponds) have been implemented on both sites, eliminating the need for washers to stay semi-immersed in mineral-laden water for long periods of time. However, a number of OHS risks remain.

In Kasulo a number of pits not in production are open and barely marked, which could lead to falls into the 10–20 m vertical shafts. The risk however is somewhat mitigated by the lack of nocturnal presence on site and the decoupling of the mining area from the neighbourhood. Complete absence of PPE on site can also result in injuries. Furthermore, despite SAEMAPE being much more robustly and effectively involved than usual and the fact that Congolese law limits the depth of underground pits and tunnels to 30 m, this limit is often flouted by miners to the knowledge of SAEMAPE so work continues unopposed.

There is a noted absence of mine-dust protection across both sites despite the known long-term effects of dust on ASM miners (Kabamba Ngombe et al., 2016). Long-term impacts of digging, transport, and washing activities that can result in back pain and other forms of reduced mobility at an older age are also not addressed at either site. These can be a significant burden for miners in their later life as there is no social safety net in place.

3.1.11. Environmental and public health impacts

Compared to the baseline, environmental impacts are mitigated. Indeed, the main direct environmental impact of ASM sites, the pollution of river and streams due to the washing process, does not occur thanks to the use of washing basins. As these basins are not connected to any stream or river, they do not generate any of this type of pollution. Once sifted and dried, the silt is either discarded or stored for processing as low-content ore. Other environmental impacts related to the generation of dust and of greenhouse gases due to transport could not be assessed within the scope of the study and are also more difficult to attribute to a single source.

3.1.12. Indigenous people rights

As indigenous communities are not present in the region, this risk is not relevant in either the baseline or in the pilot sites.

3.1.13. Minorities and discrimination

Compared to the baseline, where no risk was noted, there is no change in issues of discrimination. This risk can be considered minimal in the current circumstances.

3.1.14. Gender

Compared to the baseline, the situation in Kasulo is unchanged and there is a risk of systematic abuse in terms of gender discrimination. In Mutoshi, however, about 7–10% of diggers are female, a visible departure from the strict gender separation of roles observed on most sites.

This is linked to the open-pit nature of the site as the CSOs and SAEMAPE agents consulted have linked the work of women as diggers to the lack of underground work because the presence of a woman in a pit will sterilise it according to local superstition.

Table 2 presents the results of the assessment in a concise form, specifying:

- The situation in 2C ASM sector at large (through colour code)
- The situation on site where the programs are implemented compared to baseline (using arrows)
- Level of influence of the program on the situation (border of the arrows)

Colour codes and interpretation of signs are in Table 3.

3.2. Other considerations

The implementation of both Better Mining and MCP seem to have produced positive changes to the conditions on site but they have also created or exacerbated some issues of their own according to the CSOs and miners consulted. These issues are not reflected in the human rights risk indicators used in most due diligence or risk mapping efforts as these are not strictly covered by the reference standards.

It should be noted that the potential issues presented below mostly stand outside the scope of the systems analysed, in part due to the latter's focus on the OECD Guidance. Moreover, given the lack of available channels to seek redress on or influence the sector, both CSOs and miners tend to make demands upon systems that may be either loosely connected to the scope of these systems or go beyond said scope.

While the results of this study can be considered to be preliminary insights, considering the governance context in the DRC, these worries should be considered carefully by actors engaging with responsible cobalt sourcing initiatives.

3.2.1. Miners' income

Complementing the analysis using S-LCA categories, it was possible to partially capture aspects of income. The subcategory "wages" is composed of seven indicators, including the percentage of workers earning more or less than the living wage, the payment of bonuses and overtime, pay gaps, etc. In contrast to employees, the application of these indicators is more challenging in the context of ASM. Indeed, miners do not earn a salary and their income depends on their daily production whose value is not only determined by the volume of ore they extract but also by its cobalt (or copper) content as well as international prices. In certain buying station, moisture content of the ore is also taken into account.

With the exception of the Chemaf buying centre located in the Chemaf title, prices have been fairly regular (Fig. 3). The lower price paid at the Chemaf centre could depend on the costs the company face for the removal of the overburden, which in turn could allow the miners to increase their productivity due to having easier access to the mineral. However, it was not possible to establish the exact reasons for the lower prices during the interviews.

Assuming a living wage of \$10–15/day in the Kolwesi area (higher than the national average as the city is more expensive) and using data from BGR (2019), it was possible to establish that in the baseline scenario, 31% of the workers in the mining sector earn more than the living wage and 69% of them declare they earn lower amounts, but it was not possible to define it in the two case studies.

Miners regularly express their unhappiness with their earnings although this is not so much directed towards mineral prices as towards the perception that they are cheated during mineral content

Table 2
Results of the characterisation.

	2C ASM sector	Kasulo	Mutoshi
Presence of Armed Groups	N/R		
Presence of Armed Forces			
Serious Human Rights violations			
Forced labour			
Worst forms of Child Labour			
Corruption and bribery (at the level of the ASM miners)			
Misdeclaration of origin of minerals	Contingent on operator's declarations		
Payment of taxes	N/A		
Displacement and resettlement			
Occupational health and safety			
Environmental and public health impacts			
Indigenous peoples	N/R		
Minorities and discrimination			
Gender			

determination and weighing. This has recently led to protest at both sites. In the case of Kasulo, protests that may have been triggered by the miners' dissatisfaction with prices⁸ turned violent and led to four fatalities.

Both sites limit mineral buyers on their sites as part of their operations, and do not allow material to be sold outside, thereby creating monopsony. ASM miners perceive these monopsonies as being more prone to "cheating" as the miners cannot have their material assessed on the open market and find a buyer offering them a mineral content that is closer to what they believe is correct. Accuracy of the mineral determination could not be tested in this study.

Weighing scales have also been highlighted as another way to cheat miners especially when few competing buyers are present. Testing of the weighing scales by the author found a ± 2 kg fluctuation when measuring the weight of the author, well short of the 15 + kg discrepancies sometimes reported.

While wage level is not part of the standards that are applied when performing human rights due diligence in the sector, wage level is undoubtedly a major determinant to the living conditions of miners.

⁸ Local CSOs, COMIKU and CDM staff attribute the protests to miners not working on site and protesting against entry requirements.

Furthermore, perceived injustices can lead to protests and the involvement of Congolese armed forces, which are not trained and have often committed human right violations when confronting ASM miners.

In this respect, it is encouraging to note that as part of its approach Better Mining includes information on the prices found in Musompo market in its reporting to CDM. Income in ASM is certainly an aspect deserving further research, also in relation to responsible sourcing strategies and traceability systems.

3.2.2. Cooperatives

As highlighted by previous studies (de Haan and Geenen, 2016; De Haan and Geenen, 2015), working with a cooperative is both legally and organisationally necessary but there are concerns surrounding the fact that cooperatives do not operate in line with cooperative principles. Consequently, they are at best a form of organisation that is not accountable to its "members" nor governed by them, and can at worst be a form of organisational structure that extracts revenue from ASM miners without providing them with any benefit, except for the authorisation to work on a site. In that regard the assigning of cooperatives to specific sites by decrees is also a non-transparent procedure that raises a number of red-flags, especially as the involvement of politically exposed persons (PEPs) in cooperatives is the rule rather than the exception.

Table 3
Colour code used in the assessment.

Situation in 2C ASM sector	
	No noted risks
	No noted risks, related issues remain
	N/A (data not available)
	N/R (not relevant)
	Systematic abuse
	Systematic and grave abuse
Situation on site compared to baseline	
↑↑	Major improvement
↑	Improvement
→	No change
Influence of system on situation	
	Direct
	Through the initiative
No border	Unknown

According to the CSOs consulted, the cooperatives assigned on both sites are allegedly backed/owned by PEPs. While this cannot be substantiated in the case of the COMIAKOL cooperative, consultation of a SAEMAPE document on registered cooperatives shows that the representative of COMIKU is a relative of the Governor of Lualaba.

Furthermore, according to the CSOs and miners consulted, the assigning of COMIKU on Kasulo displaced an existing *Comité de Creuseurs* that was previously on site. Such committees are typically local “cooperatives” that lacked the resources to be formalised as such but might be more legitimate locally as they are often started by miners who are directly involved in the site.

3.2.3. Transparency

Civil society representatives point out that there remain great hurdles in the way of accessing information regarding the sites on which the pilots are implemented.

Indeed, barely any information is accessible without direct contact with project implementers even when non-commercially sensitive. Similarly, these stakeholders report that site visits are very difficult to organise for them.

A number of documents that should have been made public according to Congolese regulations and policies remain inaccessible. For example, the content of the agreement between CDM and the provincial authorities as it relates to the operation of Kasulo is not known, including the information on payments to authorities for both taxation purposes and for service delivery (presence of the PMH and of SAEMAPE on site). The exact nature of the arrangement that allows Chemaf to work with ASM miners on its site is also unknown, and while there are legal concepts that access to this knowledge under the Congolese Mining Code, local CSOs complain that they are not able to access this information.

The pictures below (Fig. 4) shows the mining and washing operations at Kasulo and Mutoshi during the site visits.

4. Discussion

As described in the review of the literature, several studies have recently been published describing the main risks and impacts of cobalt artisanal mining in the DRC. Similarly, there is a growing body of literature about the impacts, benefits, and shortcomings of minerals certification schemes and the conflict minerals policies that have been issued. To the knowledge of the authors, little is known about the initiatives on cobalt ASM, which have been launched in the last couple of years, and their impacts on workers and local communities. Given that

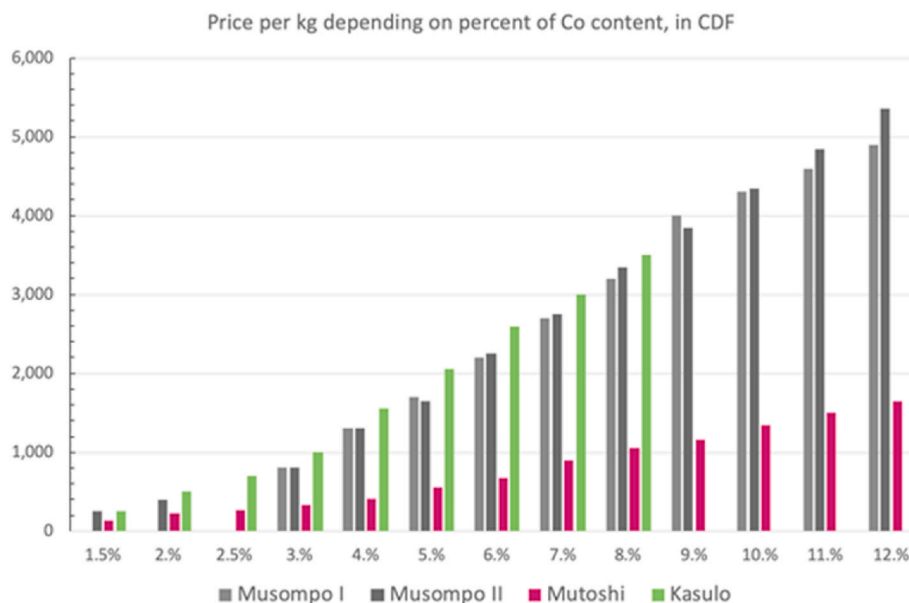


Fig. 3. Cobalt price comparison. Graph based on normalised prices (initial prices were expressed in CDF or in USD, in KG/100kg/ton) collected in two buying centres in Musompo, in a Kasulo buying house, and the prices listed at the entrance to the Mutoshi pilot. These prices were collected over a two weeks period, and might therefore reflect some variation linked to international metal price fluctuations].



Fig. 4. Pictures of the work in mining sites (cl: a) view of Kasulo site; b) Washing basin in Kasulo c) view of Mutoshi Cobalt Pilot d) Mutoshi Cobalt Pilot washing basin.

the EC has proposed mandatory due diligence requirements for cobalt and other materials used in batteries, understanding how responsible sourcing schemes can be implemented in practice, what are their impacts on local communities and workers, and how these efforts can be assessed and monitored is extremely important.

4.1. Lessons learned from the evaluation of the pilot projects for responsible sourcing of cobalt

As presented in section 4, both Better Mining and MCP have triggered or catalysed positive changes in their pilots, especially in the categories “worst forms of child labour”, “corruption and bribery”, “occupational health and safety”, and “environmental and public health impacts”. However, these programs are very dependent on the initiatives they are a part of and it was a complex task to disentangle their impacts from those of the broad initiative. Moreover, they respond to downstream expectations that do not necessarily correspond to the demands of the miners they are designed to protect. For instance, income and price calculation are particularly salient aspects not usually captured in responsible sourcing frameworks. Nevertheless, the S-LCA methodology allowed the enquiry to be expanded with additional impact categories (including positive impacts) which proved to be relevant from the stakeholder perspective.

In line with the current political agenda to develop responsible sourcing of raw materials, for example for the battery value chain (EC - European Commission, 2020), the following considerations should be taken into account:

1) As emerged in the results, income and price calculations are particularly salient aspects for local stakeholders but are not captured by

evaluations that rigidly follow downstream responsible sourcing demands. This study captured considerations related to income in the S-LCA subcategory “wages”. Critically, a significant disconnect exists between what is perceived as better working conditions by ASM miners and the demands of international standards. ASM miners are focused on day-to-day survival and for them issues such as pay and fair determination of mineral content take centre-stage, which are items not taken into account by current approaches because the latter are driven by downstream demands. It appears thus necessary to incorporate key demands from the upstream actors (e.g. income) in the scope of responsible/ethical sourcing schemes. Of course, relevant criteria/indicators might have to be developed to support this.

2) Another aspect that is currently poorly reflected in the responsible sourcing frameworks is gender discrimination. In this study, the integration of additional aspects coming from the S-LCA framework allowed this aspect to be assessed using three indicators; however, these aspects should probably be investigated more deeply, i.e. through a gender breakdown in the data collection. Indeed, gender-based violence and discrimination has been extensively reported in the literature and a 2020 OECD note also recommends that gender sensitive due diligence should be performed.⁹ Instead, this aspect was not included in the 2016 Guidelines for mineral supply chains, where only the risk of widespread sexual violence is included as one of the serious human rights abuses.

⁹ <http://mneguidelines.oecd.org/mneguidelines/Responsible-Business-Conduct-and-Gender.pdf>.

- 3) Given that the programs are implemented in the limited areas of the implementer mining sites, there were concerns among the CSOs consulted that the current efforts made and/or financed by private actors in the cobalt supply chain, while having a positive impact on the sites where they are implemented, might be used as a way to whitewash the entire production of the implementer. This could either happen by association or by unclear or confusing communication on the characteristics of the operators' cobalt production or sourcing. This concern is more acute for actors that source from a number of different ASM sources, which do not operate under the same standards as the sites where initiatives are piloted. Risk of misdeclaration concerning the origin and impact of minerals should be carefully considered if policy initiatives to promote and develop the responsible sourcing of cobalt are to be implemented. How to minimise such a risk in responsible sourcing scheme should be further investigated in the future.
- 4) Being commercially funded, both systems under investigation depend on cobalt prices remaining over a certain threshold for their continuation. Downturns in the price of the metal will impact the profitability of the operations and may lead to either a downsizing or the initiative or the systems' implementation being stopped. Being integrated into commercial initiatives, the systems may suffer from the necessity to be profitable, which can impact the prices offered to *creuseurs* (diggers) and can not only lead to friction with ASM miners but also with the CSOs representing them. Moreover, the upscaling of these pilots within a short time frame in order to respond to any increase in the demand for responsibly sourced cobalt (triggered by future legislation, for example), is an unknown factor that needs to be investigated further. In fact, the lack of land made available for ASM and the limited availability of LSM operators willing to engage in formalisation projects could be two constraints among others. In order to cope with these problems, it is hence recommended to support formalisation projects also through public funding. Indeed, financially supporting the supply of responsible cobalt from ASM would produce positive effects on mining communities, while ensuring that larger quantities of battery raw materials are produced in ethically acceptable ways.
- 5) As highlighted in other studies (e.g. [Sovacool et al., 2020](#)) profound political problems cannot be solved by responsible sourcing programs only. For instance, as observed in our study, association with a cooperative, which is a precondition for the implementation of any system integrating ASM production, is fraught with potential issues. Most of these have very close relationships with politically exposed persons, who are often the representatives of the cooperatives, and democratic control of cooperatives by their member is lacking¹⁰. Moreover, payment of the fees and membership in the cooperatives typically do not grant the miners rights or benefits. When implementing a RS program involving ASM, it is recommended to make sure that the involved cooperative authentically represents the interests of the ASM community, for instance providing credit, training, technical expertise to miners and having a more democratic and bottom-up approach in the organisation, as also suggested by [De Haan and Geenen \(2015\)](#).

The considerations listed above confirm and complement some findings of previous studies on the role of ASM and the importance of supporting it, in order to ensure socio-economic benefits in resource producing countries (e.g. [Bashwira et al., 2014](#); [Hilson and Maconachie, 2020](#); [World Economic Forum \(WEF\), 2020](#); [Zvarivadza, 2018](#)). Moreover, it expands the analysis on "ethical minerals" schemes (e.g. [Hilson et al., 2016](#); [Hofmann et al., 2015](#); [Koch and Kinsbergen, 2018](#)) to the

cobalt sector. This material, which is not included in the conflict minerals legislations, shares some of the risks faced by 3TG and came under the spotlight due to its role in batteries and in view of the European Green Deal objectives.

4.2. Limitations of the study

The study is based on a one week session of primary data collection in the mining site in October 2019, complemented by phone interviews and collection of secondary data. The assessment provides a snapshot of the impacts of the programs at the time of the investigation and according to the development status of the specific programs. In order to provide a more complete analysis, the data collection should be repeated several times so as to monitor the development of the programs and their effects. Indeed, the programs analysed operate in very complex environments and changes will take time to manifest themselves. Tenacious issues are only likely to be solved by repetitive iteration and gradual correction.

Another limitation of the study is the lack of data concerning the situation before the implementation of the programs. Ideally, the data collection should have been started before the pilots in order to compare the current conditions with the ex-ante situation. As this was not possible, a baseline scenario based on various data sources was built which was assumed to be representative of the general conditions in the sector. While this can be considered to be a limitation of the study, the proposed methodology meant the investigation could be carried out within the given constraints (of resources, access to information, etc.) and in a very problematic environment, maintaining a sufficient robustness. In future studies, ex-ante evaluations (e.g. carried out by the program implementers) would be useful to monitor the impacts of the initiative.

Concerning representativeness, the sites under investigations cover a very small share of the total cobalt production, but almost 100% of the sites having responsible sourcing initiatives implemented for cobalt. Indeed, as also noted in the [WEF \(2020\)](#) white paper, only another initiative was planned but it was not implemented at the time of data collection in October 2019¹¹. Therefore, even if the data collection was actually limited to seven working days, this time was enough to reach data saturation. Gaps on aspects that could not be assessed like payment of taxes depended on confidentiality or unwillingness to disclose this information by the stakeholders consulted.

5. Conclusions

Few systems for responsible sourcing of cobalt are actively implemented on the ground and only two of them incorporate ASM. If, as proposed by the EC, due diligence on cobalt supply chain will be mandatory for batteries sold in the EU markets in the near future, the demand for responsibly sourced cobalt will increase rapidly.

While this represents a significant opportunity for the ASM sector, some downstream companies prefer to exclude ASM from their supply chain or source from other countries in order to reduce risks. As recommended by several studies (e.g. by the OECD, BGR, WEF, etc.), the analysis in the paper confirms the relevance of ASM for the socio-economic development of mining countries, and confirms the need to support and engage with ASM formalisation. In order to avoid the exclusion of ASM from global supply chains, the design of due diligence schemes should take into account the critical issues found in the pilot projects under investigation and discussed above (e.g. risk of white washing, importance of income, and gender perspective). Moreover, that ambitious requirements might currently be too difficult for the ASM

¹⁰ Based on a review of about 15 mining cooperatives' status in the DRC in the provinces of Haut-Katanga, Lualaba, Haut-Lomami, Maniema, and South Kivu, as well as interviews with miners in Haut-Katanga, Lualaba, and Maniema.

¹¹ According to project partners news release, the project started with training to miners in October 2020 (<https://www.basf.com/global/en/media/news-releases/2020/10/p-20-350.html>, Accessed on January 2020).

to meet should be considered.

Given the constraints for scalability and continuity of these programs, which are very vulnerable to market cycles, market-based solutions from private actors should be combined with community development programs and public funding in order to ensure continuity and the upscaling of these experiences, which at the time of writing concern a negligible amount of the cobalt supply from DRC.

Finally, the study presented in this paper offers a basis for the definition of the issues of concern to be addressed in a due diligence scheme as well as for the assessment of RS programs and their monitoring through time, not only ensuring that the worst risks are avoided but also that they have positive impacts on workers and local communities. Given the outbreak of RS in the political agenda, in particular in the EU but also in some member states, agreeing on a common system of assessment, using applicable and shared metrics to determine compliance and progress will be crucial in ensuring credibility and in making real progress. In this respect, the combination of resources identified by international RS standards, in sustainability analysis, and especially S-LCA seems promising in order to include all stakeholder views in a comprehensive way. For some aspects, e.g. income, the definition of metrics adapted for the informal economy and non-salaried work requires further investigation. In addition, as far as new initiatives will be launched, further research will be required to assess their impact, in order to complement these initial results, improve knowledge of cobalt responsibly sourced from ASM, and support the policy process in ensuring a fair transition to a decarbonised economy using sustainable batteries.

Disclaimer

The views expressed in the article are personal and do not necessarily reflect an official position of the European Commission.

Declarations of competing interest

None.

Acknowledgements

We thank Eleonora D'Elia for her support in developing Fig.1.

References

- Amnesty International, 2016. This is what we die for, human rights abuses in the democratic republic of the congo power the global trade in cobalt. <https://www.amnesty.org/download/Documents/AFR6231832016ENGLISH.PDF>.
- Banza Lubaba Nkulu, C., Casas, L., Haufroid, V., De Putter, T., Saenen, N.D., Kayembe-Kitenge, T., Musa Obadia, P., Kyanika Wa Mukoma, D., Lunda Ilunga, J.-M., Nawrot, T.S., Luboya Numbi, O., Smolders, E., Nemery, B., 2018. Sustainability of artisanal mining of cobalt in DR Congo. *Nat. Sustain.* 1, 495–504. <https://doi.org/10.1038/s41893-018-0139-4>.
- Banza Lubaba Nkulu, C., Nawrot, T.S., Haufroid, V., Decrée, S., De Putter, T., Smolders, E., Kabyla, B.I., Luboya, O.N., Ilunga, A.N., Mutombo, A.M., Nemery, B., 2009. High human exposure to cobalt and other metals in Katanga, a mining area of the Democratic Republic of Congo. *Environ. Res.* 109, 745–752. <https://doi.org/10.1016/j.envres.2009.04.012>.
- Bashwira, M.-R., Cuvelier, J., Hihorist, D., van der Haar, G., 2014. Not only a man's world: women's involvement in artisanal mining in eastern DRC. *Resour. Pol.* 40, 109–116. <https://doi.org/10.1016/j.resourpol.2013.11.002>.
- Bashwira, M.-R., van der Haar, G., 2020. Necessity or choice: women's migration to artisanal mining regions in eastern DRC. *Can. J. African Stud. Can. des études africaines* 1–21.
- BGR, 2019. Mapping of the Artisanal Copper-Cobalt Mining Sector in the Provinces of Haut-Katanga and Lualaba in the Democratic Republic of the Congo. Hannover.
- Bryman, A., 2016. *Social Research Methods*. Oxford university press.
- BSR, 2016. *OECD Conformance Assessment Summary Better Sourcing Program*.
- Callaway, A., 2018. Powering down corruption. https://enoughproject.org/wpcontent/uploads/PoweringDownCorruption_Enough_Oct2018-web.pdf.
- Cheyne, K., Banza Lubaba Nkulu, C., Ngombe, L.K., Asosa, J.N., Haufroid, V., De Putter, T., Nawrot, T., Kimpanga, C.M., Numbi, O.L., Ilunga, B.K., Nemery, B., Smolders, E., 2014. Pathways of human exposure to cobalt in Katanga, a mining area of the D.R. Congo. *Sci. Total Environ.* 490, 313–321. <https://doi.org/10.1016/j.scitotenv.2014.05.014>.
- Church, C., Crawford, A., 2018. *Green Conflict Minerals*. International Institute for Sustainable Development.
- Cuvelier, J., 2017a. Money, migration and masculinity among artisanal miners in Katanga (DR Congo). *Rev. Afr. Polit. Econ.* 44, 204–219. <https://doi.org/10.1080/03056244.2016.1172061>.
- Cuvelier, J., 2017b. Leaving the beaten track: the EU regulation on conflict minerals. AFRICA POLICY BRIEFS.
- Cuvelier, J.G.R., Van Bockstael, S., Vlassenroot, K., Wakenge, C.I., 2014. Analyzing the impact of the Dodd-Frank Act on Congolese livelihoods. SSRN.
- de Brier, G., Jorns, A., 2020. How Much Does a Miner Earn? Assessment of Miner's Revenue & Basic Needs Study in the DRC. Antwerp.
- de Haan, J., Geenen, S., 2016. Mining cooperatives in Eastern DRC: the interplay between historical power relations and formal institutions. *Extr. Ind. Soc.* 3, 823–831. <https://doi.org/10.1016/j.exis.2016.05.003>.
- De Haan, J., Geenen, S., 2015. Mining Cooperatives in South Kivu: Saviour or Extortionist? Universiteit Antwerpen, Institute of Development Policy (IOB).
- Delve Database. <https://delvedatabase.org/>.
- Drive Sustainability, 2018. Responsible Minerals Initiative, the Dragonfly Initiative. Material Change: A Study Of Risks And Opportunities For Collective Action In The Materials Supply Chains Of The Automotive And Electronics Industries.
- EC - European Commission, 2020. Proposal for a Regulation of the European Parliament and of the Council Concerning Batteries and Waste Batteries. repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020. COM/2020/798 final.
- EC - European Commission, 2019. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. The European Green Deal. COM, p. 640.
- EC - European Commission, 2018. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Europe on the Move. Sustainable Mobility for Europe: Safe, Connected and Clean. COM/2018/293 final.
- Elenge, M., Leveque, A., Brouwer, C., 2013. Occupational accidents in artisanal mining in Katanga, DRC. *Int. J. Occup. Med. Environ. Health* 26, 265–274.
- Elenge, M.M., 2013. Safety and health in mining in Congo (DRC). In: List of Contents.
- Eslava, N.A., 2018. Successful Implementation of Conflict Mineral Certification and Due Diligence Schemes and the European Union's Role: Lessons Learned for Responsible Mineral Supply.
- EurAc, 2017. Accompanying Measures to the EU Regulation on Responsible Mineral Sourcing. Towards an Improved Governance of the Artisanal Mining Sector in the DRC.
- EurAc, et al., 2019. The EU Regulation on Responsible Mineral Supply and its Accompanying Measures: Views from Civil Society from Producing Countries. Workshop report.
- European Union, 2017. Regulation (EU) 2017/821 of the European Parliament and of the Council of 17 May 2017 Laying Down Supply Chain Due Diligence Obligations for Union Importers of Tin, Tantalum and Tungsten, Their Ores, and Gold Originating from Conflict-Affected and High-Risk.
- Faber, B., Krause, B., Sánchez de la Sierra, R., 2017. Artisanal Mining, Livelihoods, and Child Labor in the Cobalt Supply Chain of the Democratic Republic of Congo.
- Hilson, G., 2011. Artisanal mining, smallholder farming and livelihood diversification in rural sub-Saharan Africa: an introduction. *J. Int. Dev.* 23, 1031–1041. <https://doi.org/10.1002/jid.1829>.
- Hilson, G., Hilson, A., McQuilken, J., 2016. Ethical minerals: fairer trade for whom? *Resour. Pol.* 49, 232–247. <https://doi.org/10.1016/j.resourpol.2016.05.002>.
- Hilson, G., Maconachie, R., 2020. Artisanal and small-scale mining and the sustainable development goals: opportunities and new directions for sub-saharan Africa. *Geoforum* 111, 125–141. <https://doi.org/10.1016/j.geoforum.2019.09.006>.
- Hofmann, H., Schleper, M.C., Blome, C., 2015. Conflict minerals and supply chain due diligence: an exploratory study of multi-tier supply chains. *J. Bus. Ethics* 1–27. <https://doi.org/10.1007/s10551-015-2963-z>.
- Jørgensen, A., Finkbeiner, M., Jørgensen, M., Hauschild, M., 2010. Defining the baseline in social life cycle assessment. *Int. J. Life Cycle Assess.* 15, 376–384. <https://doi.org/10.1007/s11367-010-0176-3>.
- Kabamba Ngombe, L., Ngatu Nlandu, R., Nyembo Mukena, C., Kabyla Ilunga, B., Wembonyama Okitotsho, S., Kakoma Sakatolo, J.-B., Danuser, B., Luboya Numbi, O., 2016. Respiratory health of artisanal miner of Lwisha in Katanga/DR Congo. *Open Access Libr. J.* 3, 1–10.
- Kallio, H., Pietilä, A., Johnson, M., Kangasniemi, M., 2016. Systematic methodological review: developing a framework for a qualitative semi-structured interview guide. *J. Adv. Nurs.* 72, 2954–2965.
- Koch, D.-J., Kinsbergen, S., 2018. Exaggerating unintended effects? Competing narratives on the impact of conflict minerals regulation. *Resour. Pol.* 57, 255–263. <https://doi.org/10.1016/j.resourpol.2018.03.011>.
- Mancini, L., Eslava, N.A., Traverso, M., Mathieux, F., 2020. Responsible and Sustainable Sourcing of Batteries Raw Materials. Insights from Hotspot Analysis, Corporate Disclosures and Field Research. Publications Office of the European Union, Luxembourg. <https://doi.org/10.2760/562951>.
- Musa Obadia, P., Kayembe-Kitenge, T., Banza Lubaba Nkulu, C., Enzlin, P., Nemery, B., 2020. Erectile dysfunction and mining-related jobs: an explorative study in Lubumbashi, Democratic Republic of Congo. *Occup. Environ. Med.* 77, 19–21. <https://doi.org/10.1136/oemed-2019-105771>.
- Nordbrand, S., Bolme, P., 2007. Powering the Mobile World. Cobalt Production for Batteries in the DR Congo and Zambia.
- OECD, 2019. *Interconnected Supply Chains: a Comprehensive Look at Due Diligence Challenges and Opportunities Sourcing Cobalt and Copper from the Democratic Republic of the Congo*. Paris.

- OECD, 2016. Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas, third ed. Paris.
- Perks, R., 2011. Towards a post-conflict transition: women and artisanal mining in the democratic republic of Congo. In: *Gendering the Field: towards Sustainable*. ANU E Press, p. 177.
- Rustad, S.A., Østby, G., Nordås, R., 2016. Artisanal mining, conflict, and sexual violence in Eastern DRC. *Extr. Ind. Soc.* 3, 475–484. <https://doi.org/10.1016/J.EXIS.2016.01.010>.
- S&P Global Market Intelligence, 2019. S&P Global Market Intelligence Database.
- Scheele, F., De Haan, E., Kiezebrink, V., 2016. Cobalt Blues. SOMO Cent. Res. Multinat. Corp.
- Sovacool, B.K., 2019. The precarious political economy of cobalt: balancing prosperity, poverty, and brutality in artisanal and industrial mining in the Democratic Republic of the Congo. *Extr. Ind. Soc.* 6, 915–939. <https://doi.org/10.1016/J.EXIS.2019.05.018>.
- Sovacool, Benjamin K., Ali, S.H., Bazilian, M., Radley, B., Nemery, B., Okatz, J., Mulvaney, D., 2020. Sustainable minerals and metals for a low-carbon future. *Science* (80-.) 367, 30 LP–33. <https://doi.org/10.1126/science.aaz6003>.
- Sovacool, Benjamin K., Hook, A., Martiskainen, M., Brock, A., Turnheim, B., 2020. The decarbonisation divide: contextualizing landscapes of low-carbon exploitation and toxicity in Africa. *Global Environ. Change* 60, 102028. <https://doi.org/10.1016/J.GLOENVCHA.2019.102028>.
- Thies, C., Kieckhäfer, K., Spengler, T.S., Sodhi, M.S., 2019. Assessment of social sustainability hotspots in the supply chain of lithium-ion batteries. *Procedia CIRP* 80, 292–297. <https://doi.org/10.1016/j.procir.2018.12.009>.
- Tsurukawa, N., Prakash, S., Manhart, A., 2011. Social Impacts of Artisanal Cobalt Mining in Katanga, Democratic Republic of Congo. Öko-Institut eV, Freibg.
- UNEP/SETAC Life Cycle Initiative, 2009. Guidelines for Social Life Cycle Assessment of Products.
- UNEP, 2020. Guidelines for Social Life Cycle Assessment of Products and Organizations 2020. United Nations Environment Programme (UNEP).
- Van Brusselen, D., Kayembe-Kitenge, T., Mbuyi-Musanzayi, S., Lubala Kasole, T., Kabamba Ngombe, L., Musa Obadia, P., Kyanika wa Mukoma, D., Van Herck, K., Avonts, D., Devriendt, K., Smolders, E., Nkulu, C.B.L., Nemery, B., 2020. Metal mining and birth defects: a case-control study in Lubumbashi, Democratic Republic of the Congo. *Lancet Planet. Heal.* 4, e158–e167. [https://doi.org/10.1016/S2542-5196\(20\)30059-0](https://doi.org/10.1016/S2542-5196(20)30059-0).
- van den Brink, S., Kleijn, R., Sprecher, B., Tukker, A., 2020. Identifying supply risks by mapping the cobalt supply chain. *Resour. Conserv. Recycl.* 156, 104743 <https://doi.org/10.1016/J.RESCONREC.2020.104743>.
- WEF, 2019. A Vision for a Sustainable Battery Value Chain in 2030 Unlocking the Full Potential to Power Sustainable Development and Climate Change Mitigation. Cologny/, Geneva Switzerland.
- World Economic Forum (WEF), 2020. Making Mining Safe and Fair : Artisanal Cobalt Extraction in the Democratic Republic of the Congo.
- Zvarivadza, T., 2018. Artisanal and small-scale mining as a challenge and possible contributor to sustainable development. *Resour. Pol.* 56, 49–58. <https://doi.org/10.1016/j.resourpol.2018.01.009>.