

Minerals and the Metals for the Energy Transition: Exploring the Conflict Implications for Mineral-Rich, Fragile States



Clare Church and Alec Crawford

1 Introduction

The transition to a low-carbon economy is accelerating, in part, due to two recent, landmark international agreements. To date, 185 parties have ratified the Paris Agreement since coming into force in November 2016, which aims to keep global temperature increase below 2 °C this century (UNFCCC 2018). In addition, the Sustainable Development Goals (SDGs), adopted by the UN General Assembly in 2015, lay out a global agenda for eliminating poverty, protecting the environment and ensuring that all people can enjoy equality, peace and prosperity. SDG 13, in particular, commits UN member states to take urgent action to combat climate change and its impacts, while SDG 7 calls for affordable and clean energy for all (United Nations 2018).

With the transition underway, many actors have stepped up their efforts to contribute to climate change mitigation through the adoption of green energy technologies. The Chinese government pledged to spend USD 360 billion on clean energy projects by 2020, creating 13 million new jobs in the process (Forsythe 2017). From 2015 to 2019, more than 95% of Costa Rica's electricity was generated from renewable energy sources (Rodriguez 2019). And it isn't just states that are driving this shift; consumer preferences and the private sector are also fuelling this change. Four of Europe's biggest primary insurers have restricted or limited insurance cover for coal, for example, and the car manufacturer Volvo announced in 2018 that by 2019 all of its new vehicles would at least be partially electrified (Bosshard 2018; Watts 2017). The pace of change has been so significant that the Bloomberg New Energy

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C. Church (✉) · A. Crawford
International Institute for Sustainable Development (IISD), Vernier, Switzerland
e-mail: cchurch@iisd.ca

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Outlook predicts that wind and solar will make up 50% of the world's electricity by 2050 (BloombergNEF 2019a, b).

The demand for green energy technologies—and corresponding demand for the materials and minerals needed to build, transport and instal these technologies—is predicted to grow dramatically in the years and decades ahead. In a recent report, the World Bank estimated that demand for the minerals required for solar panels—including copper, iron, lead, molybdenum, nickel and zinc—could increase by 300% through 2050 should the international community stay on track to meet its 2 °C goal (Arrobas et al. 2017). Similarly, demand for minerals like cobalt, lithium and rare earths¹ is expected to grow at unprecedented rates due to their strategic role in the production of wind turbines, electric vehicles (EVs) and energy storage.

This increased demand should be an economic boon to those countries that are home to the principal reserves of minerals like cobalt, lithium and bauxite; increased investments in their extraction should, in a well-governed sector, result in growing revenues to the state from taxes and royalties, improved infrastructure, more jobs and increased spending on local businesses, health and education. Unfortunately, not all strategic reserves of these minerals are found in countries applying international best practice to mining sector management. As such, while green energy technologies may contribute to the achievement of SDGs 7 and 13, failure to engage in responsible sourcing practices could increase conflict and fragility risks along the green energy supply chains of these key minerals and metals, stalling or reversing local development gains. This would jeopardize the achievement of another, foundational SDG: specifically, SDG 16, which prioritizes promoting peaceful and inclusive societies, providing justice for all, and building effective, accountable, inclusive institutions (United Nations 2018).

In countries struggling with political instability, where governance for the mining sector is weak, the extraction of these minerals can be linked to violence, conflict and human rights abuses. The mining of cobalt in the Democratic Republic of Congo, for example, has so often been connected to violence that the mineral has been dubbed as the “blood diamonds of this decade” by various news outlets (Wilson 2017; Safehaven.com 2017). The extraction of nickel, a mineral critical for both solar panels and energy storage, has been linked to murder, sexual violence and forced displacement in Guatemala (Kassam 2017). And while supply chain governance for certain minerals, including tin, tungsten, tantalum, gold and diamonds, is improving, such initiatives have not yet been expanded to include most of the minerals and metals central to green energy technologies.

The technologies require to facilitate the shift to a low-carbon economy, including wind turbines, solar panels and EVs, which all require significant mineral and metal inputs and, absent any dramatic technological advances, these inputs will come from the mining sector. How they are sourced will determine whether this transition

¹The term “rare earths” refers to 17 elements often found in the same ore deposits, including cerium, dysprosium, erbium, europium, gadolinium, holmium, lanthanum, lutetium, neodymium, praseodymium, promethium, samarium, scandium, terbium, thulium, ytterbium and yttrium.

supports peaceful, sustainable development in countries where strategic reserves are found or reinforce weak governance and exacerbate local tensions and grievances.

This chapter seeks to understand the extent to which increased demand for the minerals critical to green energy technologies could affect fragility, conflict and violence in producing states, and explores what would be required of the international community to mitigate these local and national threats. It builds on extensive desk-based research, as well as a mapping analysis, case studies and findings from consultations with key stakeholders and experts.

2 Context and Background

2.1 *Green Energy and the Demand for Minerals*

The release and accumulation of greenhouse gases in the atmosphere is severely affecting the global climate. Higher temperatures, increasing variable rainfall, rising sea levels, more droughts and floods, coral bleaching and crop failure are some of the ways in which a changing climate will affect people and ecosystems. Scientists predict that temperatures will continue to rise in the coming decades and that the impacts will be felt across the globe, with varying severity and frequency depending on the region (NASA 2018). Current climate models project increases in mean temperatures, hot extremes in most inhabited regions, heavy precipitation in several regions and droughts and precipitation deficits (IPCC 2018).

In an effort to combat the impacts of climate change, 185 parties have ratified the 2016 Paris Agreement, which aims to keep global temperature increase below 2 °C above pre-industrial levels and to pursue initiatives that limit the temperature increase even further to 1.5 °C or lower (UNFCCC 2018). The key to this agreement will be a shift to a low-carbon economy, equipped with green energy technologies to decarbonize existing industries.

Within the past few years, global investments in the green energy sector have surged. Companies like Google and Amazon have made major commitments to renewable technologies, purchasing enough wind and solar power in 2017 to compensate for their energy needs (Donnelly 2017). In 2016, the deployment of new energy storage technologies—most notably batteries—grew by more than 50% (International Energy Agency 2017). And car companies—most prominently Tesla, Volvo and BMW—have taken significant strides to electrify their fleets.

This chapter will analyze four green energy technologies: solar panels, wind turbines, EVs and energy storage batteries. These technologies are already on the market, have made the biggest gains in the past decade, and are projected to increase in demand exponentially through 2050.

As the demand for these technologies grows, so too does the demand for a number of minerals required to develop and facilitate them. Solar panels, for example, were the fastest-growing source of renewable energy in 2016 (Levin Sources 2017a, b).

According to the World Bank, solar technologies could represent somewhere from 2 to 25% of total global energy production in a low-carbon economy through 2050 (Arrobas et al. 2017). While the minerals required for solar technologies vary depending on the type and make of the panel, key minerals including gallium, germanium, indium, iron, nickel, selenium, tellurium and tin.

Wind technologies are also becoming more widespread and price-competitive with traditional fossil-fuel-based energy. In Europe, wind accounted for 44% of all new power installations in 2018 (WindEurope 2019). The minerals required for wind technologies also vary, depending on whether or not they located off or onshore and whether they use geared or direct-drive technologies.²

EVs are expected to be as affordable as gas-powered cars by 2022, with the greatest demand coming from China (NetworkNewsWire 2017). Bloomberg New Energy Finance estimates that 57% of all passenger vehicle sales will be electric by 2040 (BloombergNEF 2019a, b). Lithium-ion batteries dominate the market for EV batteries, due to their excellent energy-to-weight ratio (Arrobas et al. 2017). Due to the increasing demand for EVs and energy storage batteries, the demand for and prices of minerals like lithium, cobalt and manganese—all used in lithium-ion batteries—are already rising. The price of manganese, for example, nearly doubled from 2015 to 2017 (USA News Group 2017). Other estimates suggest that, in order to meet upcoming lithium demand, at least one new lithium mine will need to begin operations each year through 2025 (Baystreet Staff 2017).

The predicted mineral requirements for each green energy technology are included in Table 1. These minerals were determined based on data from the World Bank, Levin Sources, the U.S. Geological Survey, Bloomberg New Energy Finance and the American Exploration & Mining Association. Although other minerals may be required, the minerals in the following graphic were verified and cross-referenced by multiple sources and represent strategic components of the technologies in question.

Table 1 Minerals required for green energy technologies

Green energy technology	Minerals required
Solar	Bauxite & Alumina, Cadmium, Copper, Gallium, Germanium, Indium, Iron, Lead, Nickel, Selenium, Silicon, Silver, Tellurium, Tin, Zinc
Wind	Bauxite & Alumina, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Molybdenum, Rare Earths, Zinc
Electric vehicles and energy storage	Bauxite & Alumina, Cobalt, Copper, Graphite, Iron, Lead, Lithium, Manganese, Nickel, Rare Earths, Silicon, Titanium

Source Data primarily from the World Bank (2017), Levin Sources (2017a, b), USGS (2017), Bloomberg New Energy Finance (2018) and the American Exploration & Mining Association (2013)

²Geared technologies, for example, do not require as much lead or rare earths as direct-drive, but are generally less reliable and have a lower capacity to handle intense wind speeds (Arrobas et al. 2017).

It is important to note that, due to the rapid rate of technological advances and possible opportunities for metal substitutions, these minerals are subject to change and are dependent on market fluctuations.³

The variety of minerals and metals required, and the quantities of each that will be needed, place stakeholders from across the mining life cycle—including exploration, extraction and processing entities—in a strategic position to contribute to the shift to a low-carbon economy. Exploration is expected to surge in order to meet the blooming demand and projected mineral supply deficits. However, the rate of change in the transition to a low-carbon economy has so far been too rapid for the exploration industry to keep pace; while the price of metals can increase quickly, it takes anywhere from 10 to 15 years from the discovery of a new deposit to the presence of fully operating mines at the site (Allen 2017).

Mineral recycling could alleviate some of the pressure placed on extractive operations; however, to date most of the listed minerals have poor end-of-life collection and recycling rates. Even in a scenario where recycling rates improve, studies have shown that supplies of lithium and cobalt, in particular, will still deplete significantly by 2060 (Manberger and Stenqvist 2018). As a result, the development of new technologies and metal substitution pathways are likely to play a far greater role in addressing potential supply deficits.

2.2 *A Note on Mining and Conflict*

Mineral resources—their extraction and the responsible investment of the revenues generated—can be a key driver of sustainable development. Well-managed minerals and metals can be a source of significant revenue for developing countries, revenue that, when collected and distributed transparently, can support national investments in health, education, infrastructure and other sectors crucial to a country's growth and prosperity. Large-scale mines (LSM) can be a significant source of foreign investments, jobs, shared infrastructure and procurement for local goods and services, while artisanal and small-scale mining (ASM) can provide viable livelihoods in regions where opportunities may be limited. Ensuring that mining contributes to sustainable development will depend on the presence of strong laws and policies for the sector, as well as mechanisms and institutions in place for their implementation and enforcement.

³For example, there has been some recent speculation that vanadium redox flow batteries could become a substitute for stationary lithium-ion batteries, thereby placing a greater demand on vanadium (Church 2019).

The potential for conflict,⁴ however, always exists in the mining sector—a function of the impacts of mining activities have on communities, economies and the environment (Andrews et al. 2017). These conflicts are rarely the result of a single actor, but rather the result of interactions between multiple actors including companies, governments (local, district, national), communities and civil society organizations (Andrews et al. 2017).

Conflict minerals are defined by the European Union as those minerals that “finance armed groups, fuel forced labour and other human rights abuses, and support corruption and money laundering” (European Commission 2017). Diamonds in Sierra Leone and Angola are a prominent example: gaining control of the country’s rich alluvial diamond deposits was a key incentive for rebel groups to carry out violence during the country’s civil war, and the stones were used as a funding source for their ongoing operations. Similarly, illegal tin, tungsten, tantalum and gold (3TG) mining continues to fuel violence in the DRC. Beyond Africa, armed groups exert control over 3TG operations in South American countries as well; notable examples include the ELN in Colombia and drug smugglers and illegal groups in Venezuela (Jamasmie 2017; Diaz-Struck and Poliszuk 2012). Prolonged resource conflicts contribute to further human rights abuses and facilitate corruption, as well as undermine state legitimacy and resource governance institutions.

Conflict minerals are, of course, not the sole source of tension in the sector. As mining activities expanded from 2000 to 2012 due to high commodity prices, driven by increasing global demand for raw materials, incidences of social conflicts around mining increased in parallel, driven and experienced by a diverse range of state, non-state and private actors (Dietz and Engels 2016). Between January 2006 and July 2013, 843 large-scale protest movements—relating to a range of societal issues—took place in 87 countries (Andrews et al. 2017). These protests were and continue to be most prevalent in Latin America, Africa and Asia, and have continued despite downturns in both commodity prices and mining activities. In 2017, for example, thousands of protesters in Jerada, Morocco, called for government intervention and regulation in the country’s coal mining sector, known locally as the “mines of death,” according to news reports (Leotaud 2017). In the same year in Boké, Guinea, one person died and 20 were injured by Guinean forces during protests against the impact of local bauxite mining operations.

This chapter will analyze the fragility, conflict and violence implications of both LSM and ASM operations. While the prevalence of conflict minerals is more commonly associated with ASM sites, the high rates of protests, civil unrest, environmental degradation, corruption and other financial crimes associated with LSM operations necessitate that both be examined to fully understand the range of conflict implications associated with an increased demand for minerals required for green energy technologies.

⁴It should be noted that conflict in and of itself is not necessarily a bad thing; disagreements among stakeholders can lead to dialogue, debate and constructive change. Violent conflict, conversely, is never an optimal solution to differing opinions and approaches.

3 Identifying Mineral-Rich Fragile States Critical to the Low-Carbon Transition

The minerals and metals identified as critical to the development and deployment of four key green energy technologies—solar, wind, EVs and energy storage—are presented in Table 1. These minerals include, but are not limited to aluminium, cadmium, chromium, cobalt, copper, gallium, germanium, graphite, indium, iron, lead, lithium, manganese, molybdenum, nickel, rare earths, selenium, silicon, silver, tellurium, tin and zinc. Recycling minerals—or secondary minerals—are not yet in sufficient supply to meet the predicted demand, and therefore the majority of these minerals and metals will continue to be sourced from mining sites.

Given the historical links between conflict and mining, it is essential to determine if increasing extraction of these minerals has the potential to aggravate grievances and tensions at current and future sites of extraction. Regions that are vulnerable to these dynamics were identified by overlaying fragility indicators with global reserves of identified minerals. Fragility was determined by using both the Fund for Peace's Fragile States Index as well as Transparency International's Corruption Perceptions Index. The Fragile States Index defines fragility using 12 indicators relating to internal cohesion, the economy, politics, cross-cutting factors including demographic pressures, refugees and internally displaced persons, and external intervention (The Fund for Peace 2018). Transparency International calculates perceptions of corruption in the public sector using 13 different data sources from 12 different institutions (Transparency International 2017).

Fragility and corruption measures are presented in Fig. 1; the darker the shading, the more fragile and corrupt the state is, according to 2017 and 2018 data sets. As

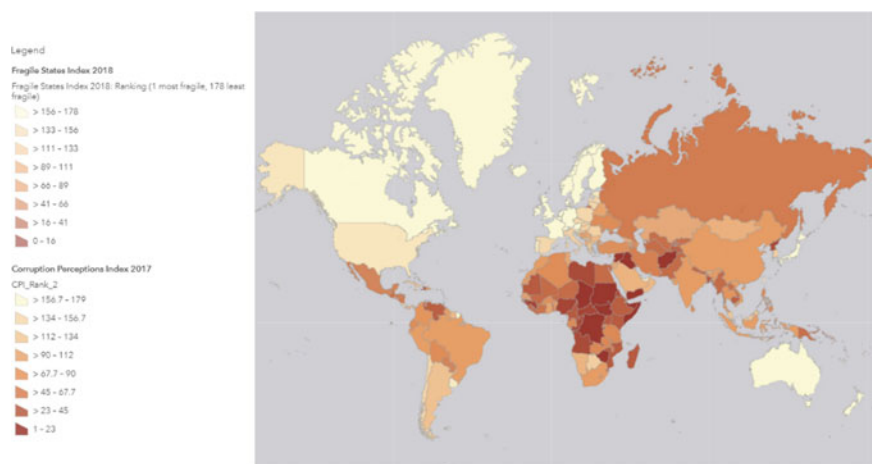


Fig. 1 Fragility and corruption indicators. *Source* Fund for Peace (2018), Transparency International (2017)

can be seen, fragility and corruption are not endemic to any one particular region; all countries struggle with these issues, to varying degrees. However, higher rates of fragility and corruption are found in the Sahel and Central Africa, the Middle East and North Africa, Southeastern Asia, Central America and some parts of South America.

Fragility indicators can next be overlaid with established mineral reserves⁵—defined as resources known to be economically feasible for extraction—to determine if any of the strategic reserves are found in countries already plagued by instability. The U.S. Geological Survey collects and disseminates data on global mineral production and reserves every year in its *Mineral Commodities Summaries*. While extensive, the report has notable data gaps resulting from reporting and collection inefficiencies, particularly in developing countries. For this reason, it is important to note that even if a country has been designated as having minimal to no mineral reserves, this does not necessarily indicate the country lacks the mineral in question, only that data is unavailable to determine if there are significant reserves.

Figure 2 overlays the location of reserves of 18 minerals that are strategic for green energy technologies with indicators of fragility and corruption, highlighting areas that may be vulnerable to conflict with the proliferation of green energy technologies. The size of the circle corresponds to the relative global quantity of the country's reserves in metric tonnes. Mineral data was unavailable for cadmium, gallium, germanium,

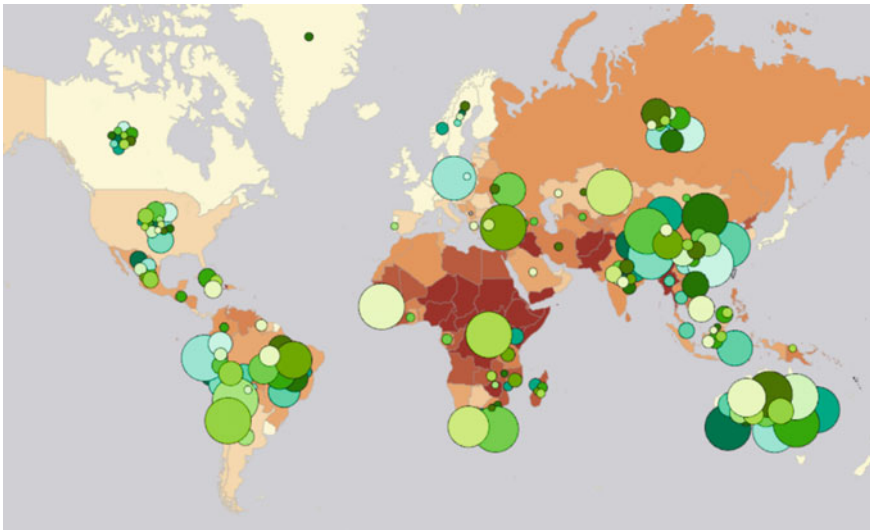


Fig. 2 Global reserves of minerals required for green energy technologies overlaid with fragility and corruption measures. *Source* Fund for Peace (2018), Transparency International (2017), U.S. Geological Survey (2018)

⁵While data on existing mineral deposits is readily available and may indicate large quantities of select minerals, these deposits have not yet been deemed economically viable and are therefore excluded from analysis.

indium and silicon. It is important to note as well that the circles signifying the reserves are geotagged to the country only, and not to a particular region within the country. Further, the colour of the circles has no significance, other than to differentiate between the different minerals.

While the map does not reflect current levels of production, the presence of strategic minerals in fragile states, coupled with the expected increase in demand for these minerals in the decades to come, point to the emergence of a number of potential hotspots for increased conflict or tension. Figure 2 demonstrates that there are significant reserves of strategic minerals in South America, sub-Saharan Africa, Southeast Asia and Australia. These regions, with the exception of Australia, have middle to high measures of fragility and corruption, highlighting areas that are potentially vulnerable to conflict with the proliferation of green energy technologies.

Table 2 Mineral reserves in states with high fragility and high corruption

Mineral	Global reserves located in a fragile or very fragile state ^a (%)	Global reserves located in states perceived to be corrupt or very corrupt ^b (%)
Bauxite and Alumina	44	68
Chromium	55	100
Cobalt	70	70
Copper	41	41
Graphite	73	100
Iron	42	60
Lead	49	49
Lithium	21	34
Manganese	66	86
Molybdenum	70	72
Nickel	42	59
Rare Earths	58	94
Selenium	76	76
Silver	52	52
Tellurium	67	67
Tin	69	84
Titanium	57	62
Zinc	52	59

Source Fund for Peace (2018), Transparency International (2017), U.S. Geological Survey (2018)

^aLabelled as “elevated warning,” “high warning,” “alert,” “high alert,” or “very high alert” on the 2018 *Fragile States Index*: receiving a score of 70.00 or higher (113.4 is the highest score, held by South Sudan).

^bReceiving a score of 43.00 or lower on the 2017 *Corruption Perceptions Index*. A score of 1 denotes a highly corrupt state; a score of 100 denotes a very clean state.

Table 2 further illustrates the possibility of conflicts emerging around these minerals. The table lists the percentage of known global reserves located in either fragile or corrupt states. Twenty-eight per cent of bauxite and alumina reserves, for example, are found in a very fragile state: Guinea. Fifty-six per cent of cobalt reserves are located in one very fragile and very corrupt state: the DRC. Notable, 100% of chromium and graphite reserves are found in states perceived to be either corrupt or very corrupt. In fact, substantial reserves of all 18 studied minerals are found in states perceived to be either corrupt or very corrupt in 2017 (Transparency International 2017).

In order to understand these conflict risks better, three case studies will be explored in further depth: cobalt in the DRC, rare earths in China and nickel in Guatemala. Each demonstrating a different geography, mineral and types of conflicts. These minerals were selected based on their importance to the development and deployment of green energy technologies and the rates of fragility and corruption where major reserves are found. Each case study examines the mineral's use in green energy technologies, as well as the conflict, fragility and violence implications of increased mineral extraction in one country, typically the country with the most reserves.

4 Case Studies

4.1 Cobalt in the DRC

Cobalt is used in the batteries of most modern electronics, including smartphones, digital music players and laptops. Critical to the low-carbon economy, cobalt is also instrumental for the development and facilitation of EVs and energy storage technologies. For EVs in particular, cobalt is found in three out of the four major lithium-ion batteries on the market: lithium cobalt oxides, nickel manganese cobalt and nickel cobalt aluminium (Levin Sources 2017a, b). Lithium-ion batteries are also used to store energy derived from solar, wind and other green technologies, thereby making the batteries—and the minerals required to power them—an integral part in the transition to a low-carbon economy.

Surging demand for cobalt has been a recurring theme in recent headlines. The World Bank estimated that if the international community is able to keep global temperature rise to 2 °C (instead of the project 6 °C) through the widespread adoption of green energy, demand for cobalt could see an increase of an exponential magnitude (Arrobas et al. 2017). Future demand and pricing are largely predicated on changes in the automotive industry, namely, the shift toward lithium-ion batteries. Some estimates suggest that the price of cobalt could increase to USD 100,000 per tonne by 2030 (compared to USD 60,000 per tonne in 2017) as a result of the transition to EVs and green energy storage technologies (NetworkNewsWire 2017). Much of this demand comes from Chinese manufacturing and consumer markets.

Global cobalt supply is subject to potential shortages. Some estimates suggest a 20% global cobalt supply gap by 2025, even with new mining operations in Canada coming online in the interim (Safehaven.com 2017). The British Geological Survey’s 2015 Risk List gave cobalt a score of 8.1 out of 10, indicating a relatively high supply risk (British Geological Survey 2015). In addition to unprecedented demand for the mineral, this risk and supply gap is in part due to the way that cobalt is mined; cobalt is mined as a by-product of either nickel or copper and therefore can be dependent on price fluctuations and demand of the two. Cobalt can be mined through both ASM and LSM operations.

Cobalt supply is also designated as high risk because fragile countries host a large majority of the cobalt reserves and production. The DRC has the largest global reserves of cobalt, as demonstrated in Fig. 3, with an estimated 3,500,000 metric tonnes—50% of world reserves (U.S. Geological Survey 2018). Other, less significant reserves are found in Australia, Cuba, the Philippines, Zambia, Russia, Canada, Madagascar, Papua New Guinea, South Africa and the United States (U.S. Geological Survey 2018).

Despite a vast wealth of mineral resources and biodiversity, the DRC’s recent history has been defined by fragility, corruption and violence. The centre of what was called Africa’s World War, or the Second Congo War, from 1998 to 2003, legacies of human rights abuse, weak governance and exploitative practices still permeate the lives of many Congolese citizens. The country still scores high on global indicators of fragility and corruption, ranked the 5th most fragile country in the world and the 19th most corrupt (The Fund for Peace 2019; Transparency International 2019). And

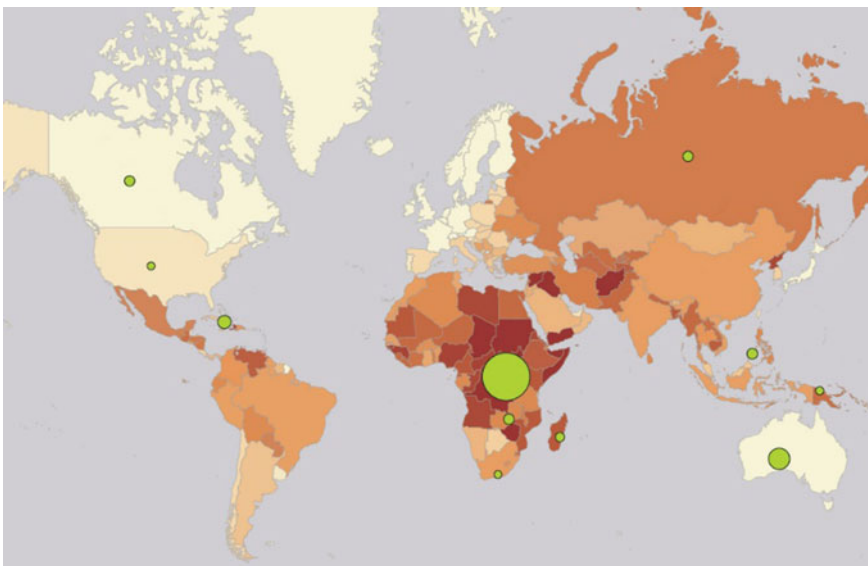


Fig. 3 Global cobalt reserves overlaid with fragility and corruption measures. *Source* Fund for Peace (2018), Transparency International (2017), U.S. Geological Survey (2018)

although the Ibrahim Index of African Governance demonstrates that, in recent years, the DRC has shown increasing improvement in developing a sustainable economy, it also highlights a continued deterioration of human development, political participation and human rights (IIAG 2016). Its positive peace ranking is low, indicating that despite marginal economic improvements, the state's stability is still prone to shocks (Institute for Economics & Peace 2017).

The DRC's mining industry is its largest source of export income (BBC News 2018a, b). In addition to cobalt, the country is a major global producer of copper, tantalum, tin and gold. Despite the potential the DRC's mineral wealth holds for its economy and development, the country's history of war, weak governance and grand corruption pose a risk to the responsible management of ongoing mining operations.

The DRC's resource governance scores have either been poor or on the cusp of failing for years, indicating that there are minimal established procedures and practices to govern the country's minerals (Natural Resources Governance Institute 2017). Throughout and after the Second Congo War, mineral resources, including 3TG, fuelled violence and human rights violations. Illegal armed groups fought for control of the mines, exploited miners and used profits from the minerals to fund their continued violence. These activities, in addition to other global examples, contributed to the emergency of thinking on "conflict minerals," referring to minerals that are extracted from conflict zones and fund continued violence.

In addition to conflict and violence, mineral resources in the DRC can be subject to corruption schemes and financial crimes. Corruption can erode the social contract between the state and its citizens, diverting funding away from the core services that need it most and impoverish communities, further exacerbating fragility.

The continued permeation of fragility, conflict and violence into the mining sector as well as ongoing records of corruption and weak governance pose considerable risks for the responsible extraction of Congolese cobalt for green energy technologies. Already, cobalt has been tied to some of the same exploitative and violent practices seen in the mining of 3TG; these mines have been connected to child labour, dangerous working conditions, extortion and human rights abuses.

Approximately 10% of the global supply of cobalt, and 20% of the DRC's total exports, comes from ASM operations (Amnesty International 2017). ASM sites are not inherently dangerous, but are prone to risk due to minimal oversight, regulation and safety measures (Reuters 2018). ASM operations can be associated with high rates of death and injuries, due to the lack of safety equipment and protective gear.

In 2016, Amnesty International visited ASM operations in the south of the DRC and interviewed workers at five mining sites. Researchers interviewed 17 children, all of whom were employed at the mining sites for less than USD 2 per day, and found that several children had been beaten by the mining companies' security guards for trespassing on the companies' concessions (Amnesty International & Afrewatch 2016). The researchers also found that workers did not have access to protective equipment, were exposed to harmful chemicals and that state officials extorted illegal payments from the artisanal miners (Amnesty International & Afrewatch 2016).

As a result of these risks, some companies have tried to avoid sourcing from the DRC altogether, looking instead to Australia, Canada or the Philippines. Given the

DRC's rich reserves, however, leading producers of cobalt will most likely continue to work in the African country. Efforts should be focused on mitigating conflict risks by addressing its root causes and stopping human rights abuses around the DRC's mining sites, which will ultimately improve certainty in the supply chain.

Despite the relatively widespread reporting of these ongoing conflict implications, only marginal improvements have been made to secure the responsible sourcing of cobalt. Cobalt is not officially classified as a conflict mineral in legislation like the U.S. Dodd–Frank Act or the European Union's Conflict Mineral regulation. Any regulations aimed at curbing the illegal flow of conflict minerals, therefore, may not explicitly apply to cobalt. Some groups—like the World Economic Forum's Global Battery Alliance and the Responsible Cobalt Initiative—have started to take measures to address these inefficiencies and gaps in international legislation and supply chain governance. However, given the ongoing human rights abuses and surging demand for cobalt, additional improvements in the responsible sourcing of cobalt are still sorely needed.

4.2 *Rare Earths in China*

The term “rare earths” refers to 17 different elements, often found together in the Earth's crust. Of the 17, three are of particular importance to the development of green energy technologies: dysprosium, neodymium and praseodymium. These minerals are necessary for the production of specialized magnets used in both EVs and energy storage technologies as well as wind turbines. The magnets are favoured for EVs because they are generally lighter, stronger and more efficient than induction motors that rely on copper coils (Desai 2018). Similarly, use of these magnets has significant advantages in the production of wind turbines, cited for their efficiency, weight, size and maintenance properties (Pavel et al. 2017). The World Bank notes that the use of these magnets in wind turbines is preferred, particularly for offshore turbines, due to their reliability and capacity to handle higher wind speeds (Arrobas et al. 2017). Some substitutions are available for rare earths; however, most of these are still in the research phase and in general have been found to be less effective.

The prices of wind turbines and EVs are increasingly competitive, making the deployment of both a rapid reality. The demand for rare earths to meet this reality, and for neodymium and praseodymium in particular, is expected to surge in the coming years with this transition. The global demand for neodymium in 2017 was approximately 31,700 tonnes, outstripping supply by 3,300 tonnes (Desai 2018). And without viable substitutions, demand for neodymium will need to increase by more than 250% through 2050 for the international community to meet its Paris Agreement goals (Arrobas et al. 2017).

Both the demand for and supply for rare earths are concentrated in China. China accounted for 80% of rare earth production in 2017 and is home to 36% of world reserves, as shown in Fig. 4 (U.S. Geological Survey 2018). Reserves are also located in Vietnam, Brazil, Russia, India, Australia, the United States, Canada, South Africa,

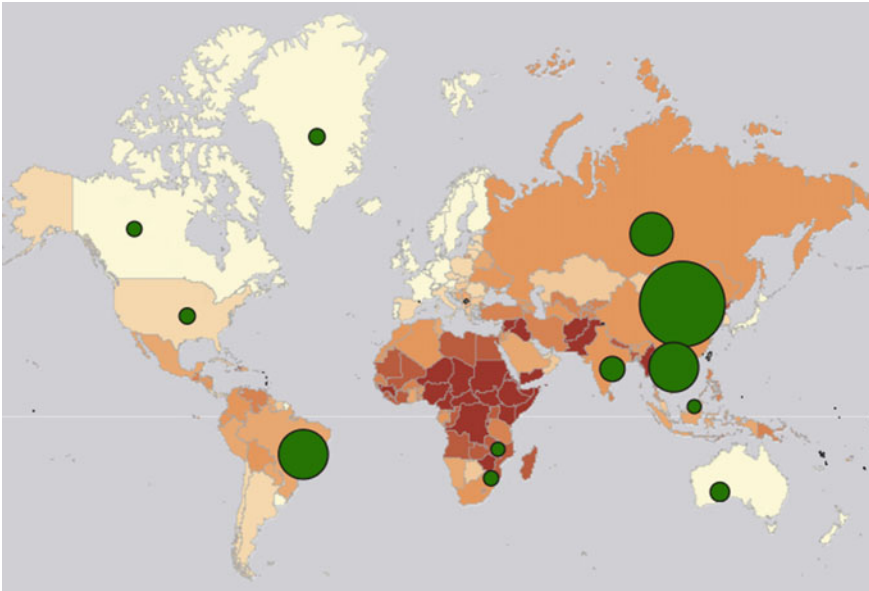


Fig. 4 Rare earths reserves overlaid with fragility and corruption measures. *Source* Fund for Peace (2018), Transparency International (2017), U.S. Geological Survey (2018)

Malawi and Malaysia, but these are yet to be developed to the same extent as the Chinese reserves (Australia hosts the only other major rare earths operations in the world). Increasing demand for and prices of rare earths are spurring the rapid development of rare earths projects around the world; however, most of the projects will not come online until the last 2020s. China's monopoly of the rare earths market, however, is set to continue for the coming decade at a minimum (Shaw 2017).

In addition to rare earths, China is rich in multiple mineral resources key to green energy technologies. Most notably, China has some of the largest global reserves of lead, selenium, tellurium, tin and zinc, which are critical to solar technology, as well as graphite, lithium and titanium, which are critical for EVs and energy storage technologies. The country also has reserves of bauxite and alumina, copper, iron, manganese, nickel and silver. This vast mineral wealth places China in a unique global position, in some cases allowing the state to exert a quasi-monopoly on several critical minerals. A number of producers and refiners for minerals required for green energy technologies, including cobalt, are also located in China. Virtually all lithium-ion battery production is done in China: the country is the largest global importer of cobalt, nickel and manganese, as well as lithium, despite having large reserves of its own (RCS Global 2017). As such, most discussions of green energy supply chains must include China.

China has mid-range scores of fragility and corruption (Fund for Peace 2019; Transparency International 2019). It has high positive peace scores, indicating high levels of resilience and the appropriate attitudes, institutions and structures needed

to sustain a peaceful society (Institute for Economics & Peace 2017). However, the Natural Resource Governance Institute labels China's resource governance as "weak," indicating that the sector has a mix of strong and problematic areas of governance; indicators like value realization, revenue management and establishing an enabling environment for extraction have ample room to improve (Natural Resources Governance Institute 2017).

Mining and industrial development more generally in China have often come at the cost of the environment, growing alongside dangerous levels of air and water pollution. Since the 1990s, environmental activism, driven by localized grievances against pollution, has grown and manifested in the form of protests, petitions and, in some cases, violence (Ho and Yang 2018). In 2011, communities from the Qinghai province in China, for example, urged the government to take action against lead mining in the Ganhetan Industrial District, which was known to cause high levels of water pollution and endanger the lives of local residents (Environmental Justice Atlas 2018). Similar protests and pleas have also been recorded against controversial copper mining in Tibet, gold mining along the Gu Chu River, cadmium extraction in the Guangdong Province and cement production in the Madang Province (Environmental Justice Atlas 2018).

Rare earth mining can be both destructive and toxic to surrounding environments. Almost all rare earth ores contain the radioactive elements thorium and uranium (Huang et al. 2016). As a result, the extraction and processing of rare earths can be highly toxic and have a negative effect on soil, water and human health. In 1958, the Baotou Iron and Steel Company began producing rare earths near the city of Baotou in Inner Mongolia; by 1980 crops in the nearby villages had already started to fail due to pollution of soil and groundwater attributed to rare earth mining and processing (Bontron 2012). Today, the lands surrounding Baotou are stripped of topsoil while streambeds contain thousands of gallons of acid (Bradsher 2010a, b). Dalahai village, located close to a Baotou rare earths tailing pond, has been named a "death village" due to the high incidence of lung cancer, brain cancer, respiratory illnesses and cardiovascular diseases suffered by local residents (Huang et al. 2016). Ganzhou, the so-called "rare earths kingdom," has been described as a "site of devastation" by the *ChinaDialogue*, plagued as it is with crude open air mines, smelters, polluted water supplies and reduced crop yields (Hongqiao 2016). Coupled with the growth of environmental activism, rare earths mining in China could lead to increasing tensions at the local level.

The nature of deposits located in the southern province of Ganzhou makes rare earth extraction relatively easier than in Inner Mongolia. These deposits are also free of radioactive thorium. However, as a result of the ease of extraction and raising global prices for rare earths, a substantial number of illegal rare earth mines emerged in the area. These mines are cited to sell to organized crime syndicates and exploit workers, some of which are children (Bradsher 2010a, b; Schlanger 2017). Some estimates suggest that tens of thousands of tonnes of rare earths are illegally mined and sold on China's black market every year (Hongqiao 2016). In response, both the central and provincial governments have taken measures against illegal mining operations, including instituting new regulations against illegal exploration as well

as dispatching police to outlaw the illegal mines (Yan 2012). The traceability of rare earths supply chains, however, is still relatively unexplored, and is not regulated to the same extent as other conflict minerals.

In addition to the risks of exacerbating local and global grievances surrounding pollution and public health, China's majority share of rare earth production has been used as political–economic leverage in past state-level disputes. In 2010, amid a territorial disagreement over disputed islands with Japan, China suspended its shipments of rare earths to its neighbour (Bradsher 2010a, b). Chinese officials later lifted the embargo and denied that the ban was in response to the dispute with Japan, but that they had instead reduced export quotas to mitigate pollution and environmental concerns (Bradsher 2010a, b). Nevertheless, the period raised a number of concerns with companies and countries around the world regarding the diminishing supply, rising prices and implications of China's dominant position in the rare earths market. More recently, concerns have been raised that China could use this position for leverage in the trade war between the U.S. and China (Reuters 2019).

4.3 *Nickel in Guatemala*

Cobalt, lithium and rare earths tend to dominate the discussions around the minerals required for the green energy transition. This is in part due to the fact that base metals like nickel are not exclusively produced for green energy technologies; nickel is used in more than 300,000 products worldwide, including those with consumer, industrial aerospace, marine and architectural applications (Nickel Institute n.d.). Of the 2.1 million metric tonnes of nickel content produced in 2017, approximately 65% was used to manufacture stainless steel, while only 6% was devoted to the production of coins, electronics and rechargeable batteries (U.S. Geological Survey 2018; Nickel Institute n.d.). However, its use in the production of steel is also expected to benefit from green energy technologies, and its use in rechargeable batteries is expected to comprise a growing share of nickel production annually. Nickel can only be mined through LSM operations.

Nickel is required for multiple green energy technologies. Currently, two types of lithium-ion batteries make up the majority of the EV market due to their efficiency, price and ease in manufacturing: nickel manganese cobalt and nickel cobalt aluminium batteries (Hunt 2018). A rate of 30 and 80% of nickel is required for nickel manganese cobalt and nickel cobalt aluminium batteries, respectively. As such, nickel will be crucially important to the green energy transition, regardless of which EV battery leads production in the coming decade (Hunt 2018). Nickel is also instrumental in solar technologies; according to the World Bank, the transition to solar could increase the demand for nickel by 300% through 2050 (Arrobas et al. 2017). This number increases dramatically when EVs and energy storage technologies are included, with a predicted increase in demand for nickel of up to 1,200% (Arrobas et al. 2017).

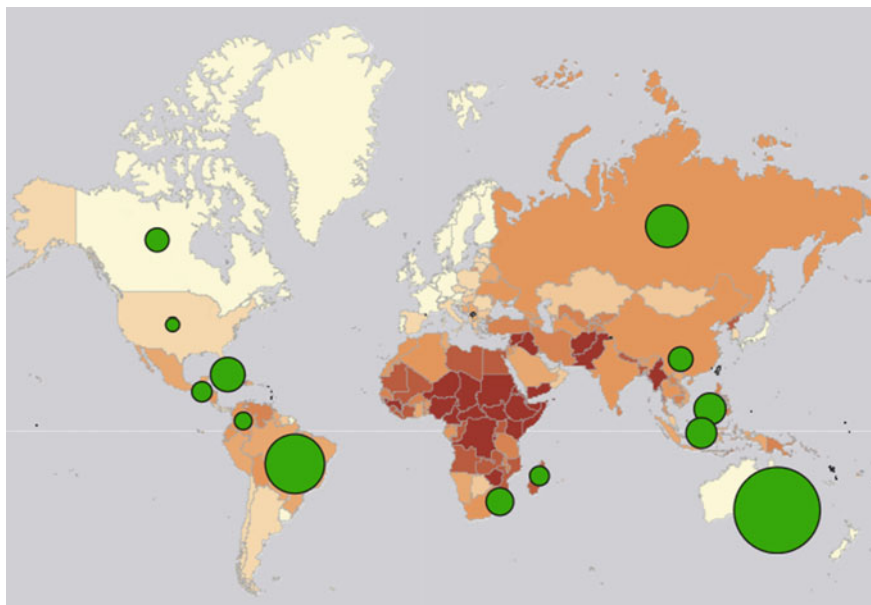


Fig. 5 Nickel reserves overlaid with fragility and corruption measures. *Source* Fund for Peace (2018), Transparency International (2017), U.S. Geological Survey (2018)

Nickel is mined in more than 40 countries, with significant quantities of reserves in 13, shown in Fig. 5 (U.S. Geological Survey 2018). However, of these reserves, 38% are found in states given an “elevated warning” label or worse on the Fragile States Index (Fund for Peace 2018), and 54% of reserves are located in states perceived to be corrupt or very corrupt (Transparency International 2017). Guatemala is currently ranked 10th in terms of world reserves, with an estimated 1,800,000 metric tonnes of nickel content (U.S. Geological Survey 2018).

Guatemala is one of the most resource-rich and populated countries in Central America. Despite this richness, the country ranks poorly on indicators of fragility, corruption and violence (Fund for Peace 2019; Transparency International 2019). Although the Indigenous Maya comprise almost 50% of the population, they are disproportionately affected by development challenges and the negative impacts of the country’s mining industry (BBC News 2018a, b).

Mining activity currently makes up approximately 3% of Guatemala’s overall GDP (MICLA n.d.). Along with nickel, Guatemala possesses rich deposits of gold, silver and copper, although not all have been economically viable to mine. On the 2017 Resource Governance Index, Guatemala’s mining sector was given a “poor” ranking, having established minimal procedures and practices to govern resources (Natural Resources Governance Institute 2017).

Nickel mining is relatively new to Guatemala, having emerged during the country’s armed internal conflict, which began in the early 1960s and lasted until 1996. At

the height of this violence, the Canadian mining firm INCO (previously the International Nickel Company, now Vale) won a monopoly on nickel extraction in Central America, and controlled nearly 54% of the nickel market in North and South America (Price 2015). New mines were primarily opened in Guatemala's rural areas, where the majority of Indigenous Maya people reside. Indigenous opposition to mining during the civil war manifested as protests against illegal land use, environmental degradation, and connections to colonialism associated with LSM operations. In response, armed groups and private security forces were sometimes deployed to remove indigenous-led opposition to mining (Price 2015).

Throughout the armed internal conflict, more than 200,000 civilians were killed and more than 1.5 million displaced (Agence France-Presse 2015; PBS News Hour 2011). Guatemala's Historical Clarification Commission later found that the majority of these abuses were perpetrated by the state military and that 83% of victims were Indigenous Maya (Amnesty International 2014).

A recent report by Amnesty International found that mining companies in Guatemala throughout the civil war neglected to address existing community tensions and in many cases "failed to adhere to international standards on business and human rights" in regards to consultation and security operations (Amnesty International 2014). Although the civil war ended in 1996, the legacy of violence continues to affect Guatemalan society, oftentimes manifesting around the mining of nickel.

Fenix Mining project is one of the largest nickel mines in Central America (Hill 2014). Throughout the past decade, the project—located near the Lote Ocho Indigenous community in El Estor—has been linked to allegations of forced displacement, murder and sexual violence. Due to poor access to dispute resolution mechanisms and a weak judiciary, victims—the majority of which are Indigenous—have up to date been unable to successfully bring criminal cases against their perpetrators within Guatemala (Kassam 2017). Some victims, however, have been able to bring forward civil lawsuits in the home jurisdictions of the foreign mining companies that own the mine (and their subsidiaries) (Kassam 2017).

In the case of *Caal v. HudBay*, 11 Maya Q'eqchi' women are suing the mining company HudBay in its home jurisdiction of Ontario (Klippensteins et al. 2018). The women allege that in January 2007, private security personnel from the Fenix mining project forced villagers off their ancestral lands, burned their homes and sexually assaulted the women (Klippensteins et al. 2018). In addition to this lawsuit, community groups are suing HudBay and its subsidiaries for the 2009 murder of the community leader Adolfo Ich Chamán and the shooting of German Chub Choc. HudBay denies culpability, stating that the sexual assaults were carried before their involvement in the mine and that mining personnel were not involved in the 2009 evictions; HudBay bought the mine from the Guatemalan Nickel Company in 2008 (Kassam 2017; Price 2015; Hudbay Minerals Inc. 2017).

While these cases represent a landmark move to bridge the disconnect between foreign mining companies and the actions of its local subsidiaries, they also reflect how increased mineral demand in resource-rich states like Guatemala can result in an exacerbation of land ownership disputes between private companies, governments and community groups. A decade after the aforementioned incidents, nickel mining

in Central America is still associated with the destruction of surface land resources, a primary source of livelihoods for many Indigenous communities (Fox 2014).

If the demand for nickel increases at its predicted rates, it is essential to ensure that mining companies and governments adhere to international human rights and business law, as well as actively respect the human and land rights of Indigenous persons. This consideration, as well as improved access to effective dispute resolutions, will be necessary to mitigate ongoing community tensions and grievances surrounding extraction, and to contribute to the responsible supply chain governance of nickel and other base metals.

5 Supply Chain Governance

Some states, international agencies and private sector entities have introduced legislation and guidance to curb the flow of conflict minerals and promote responsible and transparent mineral supply chains. This includes the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas. In line with the UN Guiding Principles of Business and Human Rights, the OECD guidance provides a framework for companies operating in contexts of fragility to conduct due diligence on their supply chains by assessing potential risks, preventing and mitigating these identified risks, and adopting a risk management plan (OECD 2016). The guidance applies to all minerals, but has specific supplements for 3TG.

The European Union (EU) Conflict Minerals Regulation comes into force on January 1, 2021 and is designed to ensure that all EU importers of 3TG meet the OECD Guidance. The regulation directly applies to almost 1,000 EU importers and indirectly applies to 500 smelters and refiners of 3TG, based both inside and outside the EU (European Commission 2017). As the regulation only applies to 3TG, the aforementioned minerals will not be directly affected. However, additional minerals could be added to the regulation in 2024, when the EU executive is set to undergo a review of the bill.

The Chinese Chamber of Commerce for Metals, Minerals & Chemicals Importers & Exporters (2015) also introduced a framework to operationalize the OECD Guidance. The framework provides guidelines and tools to those Chinese companies that extract or use minerals in their products to help them identify, prevent and mitigate risks of conflict, human rights abuses and misconduct throughout the entire mining life cycle. The framework can be applied to all minerals, however, remains voluntary.

The U.S. Dodd-Frank Act is another prominent mechanism to promote responsible mineral supply chains, though with more limited geographic scope. Passed in 2010, Section 1502 of the Act requires U.S. publicly traded companies to assess and address any risks in the supply chains of 3TG that may originate from the DRC or neighbouring countries. While the scope of this legislation neglects the potential for other minerals and regions beyond sub-Saharan Africa to finance armed groups

in mineral-rich fragile states, the legislation is a landmark example of public sector action against corruption, human rights abuses and violence in the mining sector.

In addition to these public sector mechanisms, civil society groups and private sector actors have also taken steps to ensure the responsible sourcing of minerals and metals. The Extractive Industries Transparency Initiative (EITI), for example, promotes the open and accountable management of oil, gas and mineral resources (EITI 2018). In addition, the London Metals Exchange (LME), the world's biggest market for industrial metals, has increased efforts to monitor and investigate cobalt sources. In July 2018, LME announced that it would require all companies that receive a minimum of 25% of their metal from ASM mines in the DRC to undergo a professional audit (Desai and Daly 2018). These moves demonstrate the growing awareness of the conflict-related risks associated with cobalt extraction in fragile states.

Industry schemes like the Responsible Minerals Initiative (RMI) are also contributing to the improved international governance of mineral supply chains. RMI is a coalition of more than 360 member companies aiming to improve the human rights conditions of mineral supply chains, by administering third-party audits of mineral sourcing in conflict-affected and high-risk areas (Sustainable Brands 2018). In 2016, the OECD began to assess five industry schemes, including RMI, regarding the schemes' alignment with the OECD Guidance and overall due diligence in sourcing practices. Although the official policies of the industry schemes were increasingly aligned with the OECD Guidance, the assessment found in its 2018 report that implementation of the due diligence processes lagged behind alignment (OECD 2018). Reporting and monitoring by civil society groups have pointed to sometimes shallow improvement in due diligence practices by mining companies and industries as well. The Responsible Sourcing Network, for example, assess companies' efforts to provide strong supply chain due diligence in their use of conflict minerals (Deberdt and Jurewicz 2017). The report found that, although more than 70% of assessed companies followed the OECD guidelines, most did so only superficially and few used the guidance in full (Deberdt and Jurewicz 2017).

The implementation gap is common across the various public sector, private sector and civil society actions to monitor and regulate the mineral supply chain, posing a risk to the responsible sourcing of green energy technologies and the minerals required to develop and deploy them. While legislation like Section 1502 of the Dodd–Frank Act and the upcoming EU Conflict Minerals Regulation represent significant milestones to responsible mineral governance, many are not yet applicable to minerals beyond 3TG. In the past few years, the conflict risks of cobalt sourcing have started to garner international attention. Subsequently, some civil society groups and private sector actors have started to incorporate responsible cobalt sourcing into their mandates. However, the supply chains and associated risks of other green conflict minerals like bauxite and alumina, lithium, nickel and rare earths are still largely unexplored and therefore largely absent from the current field of mineral supply chain governance.

6 Recommendations and Conclusions

Mining can be an inherently risky industry. Companies and small-scale miners alike constantly struggle with accessing uncertain deposits, managing volatile commodity prices, ensuring worker health and safety, and avoiding environmental catastrophe. Conflict adds another, significant risk to mining: it can interrupt operations, undermine the social license to operate, damage reputations and, at its most extreme, threaten the lives of those involved. Conflict and fragility are bad for business, communities and governments, and reducing conflict risks is in the interests of all stakeholders.

For minerals required to make the transition to a low-carbon economy, there are real risks of grievances, tensions and conflicts emerging or continuing, as has been made clear in the case studies and mapping exercise presented. For fragile states, weak governance, corruption and the inadequate implementation and enforcement of existing laws all work against ensuring that the benefits of mining accrue to the population and the country's sustainable development. Local voices are often left out of important decision-making, and meaningful engagement with communities does not always occur prior to the start of mining activities. Depending on the mineral, individuals can be subject to health and safety violations, human rights abuses, environmental risks and child labour.

There remains a lack of transparency across a number of key supply chains, including those for cobalt, lithium and bauxite. This opaqueness extends to the recycling industry, which will be increasingly important part of mineral and material provision in the future. Regulations and laws supporting increased transparency are not yet widespread enough to capture all relevant minerals, though important lessons can be drawn from international efforts to eliminate conflict from 3TG supply chains. The complexity of these supply chains, which include miners, traders, smelters, refiners, manufacturers, transporters and consumers, can be intimidating, but should not deter the international community from the important work that needs to be done to ensure they are conflict free.

Governments, the private sector and civil society should work together to ensure that the transition to a low-carbon economy, and the subsequent sourcing from mineral-rich fragile states, is conducted in a way which promotes peace, stability and sustainability. While some of the foundations are in place to ensure that these critical minerals do not emerge as conflict minerals in the coming decades, these must be extended and strengthened. In particular, communities should be engaged in a meaningful way across the mineral life cycle, transparency promoted, existing supply chain regulations should be expanded to apply to more minerals, and the implementation of these regulations improved.

To meet the aims of the Paris Agreement and the Sustainable Development Goals, it is imperative that we transition to a low-carbon economy. Green energy technologies like wind turbines, solar panels, EVs and improved energy storage will aid in this transition. However, the emergence or exacerbation of fragility, conflict and violence along the supply chains of the minerals needed to produce these technologies could

threaten the overall “green” nature of this transition. In order to meet global goals around sustainable development and climate change mitigation, while contributing to lasting peace, the supply chains of these strategic minerals must be governed in a way that is responsible, accountable and transparent. Achieving this vision will require concerted effort from civil society, the private sector and governments.

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