

**The Paradox of the Green Energy Revolution: Does Chinese Cobalt Mining in the
Democratic Republic of the Congo Undercut Benefits of Green Energy?**

Undergraduate Honors Thesis

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by

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Abstract

A quick, sustainable, and just transition to green energy sources from fossil fuels is vital to avoiding the worst impacts of climate change. The International Labor Organization defines a just transition as “greening the economy in a way that is as fair and inclusive as possible to everyone concerned, creating decent work opportunities and leaving no one behind.”¹ To mitigate the years of high greenhouse gas (GHG) emissions from wealthy and industrializing countries which have disproportionately impacted poorer, more vulnerable countries, a just transition is essential. The impacts of these high emissions include, but are not limited to, flooding, typhoons, hurricanes, earthquakes, mudslides, and desertification. Recognizing this, a new emphasis has been placed on sustainability in the last decade. Vital to this transition are batteries made from cobalt that go in electric vehicles (EVs), wind turbines, and solar panels. The Democratic Republic of the Congo (DRC) is home to an estimated 70% of the world’s cobalt deposits of which China controls around 80%.² China produces over half of the world’s cobalt-containing lithium-ion batteries powering the green energy transition. Growing importance of lithium-ion batteries calls for an in-depth look at the actual sustainability of cobalt mining and its supply chain before labeling battery power as clean energy.

¹ “Green Jobs: What are Green Jobs?” International Labor Organization, 2021.

² Stephen Chen, “Chinese in Beijing Manage Cobalt Mines in Africa by Remote Control: Study,” South China Morning Post, December 7, 2022.

Introduction

Energy insecurity is an intrinsic characteristic of the People's Republic of China in the 21st century. Deng Xiaoping's modernization reforms in 1978 and China's accession to the WTO in 2001 cemented China's role as the world's factory. Since then, energy security has skyrocketed to the forefront of its agenda. China realized that in order to power its industry, energy and natural resources would need to flow in from foreign deposits. As such, China has become the world's largest importer of energy.³ While economic growth has brought China enormous prosperity over the last four decades, there is considerable concern that reliance on fossil fuels may be unsustainable for the planet. China has pursued mining contracts in nations such as the DRC to secure access to minerals involved in sustainable energy generation for domestic use and foreign exportation in exchange for infrastructure investments. Renewable sources of energy show great promise to untether China's economic outcomes from its environmental impacts, but they also bring challenges that may be no less harrowing for the earth and its inhabitants.

Since the early 2000s, China has invested significant effort in securing the DRC's mineral resources. One such method of winning these spoils is through infrastructure loans in exchange for cobalt mining concessions. While these resource-backed loans seem to promise the best of both worlds - foreign investment and domestic infrastructure progress - the negative consequences of Chinese efforts to secure cobalt might outweigh the theoretical benefits. The DRC has existed in a state of civil conflict since 1996, ensuring instability in this post-colonial nation. As such, while cash flows from Chinese mining projects have contributed to civil infrastructure, they have also contributed to funding corruption and violence. Now, with such a

³ "Statistical Review of World Energy," British Petroleum Co. 2021.

focus on the importance of cobalt in the green energy revolution, the world is watching this dynamic questioning the supply chain of their technologies. With a new global focus on green energy, the relationship between China and the DRC will remain critical to both partners, but also to all nations involved in the supply chain. To examine the question “are the sustainability benefits of green energy outweighed by human rights and environmental abuses in the DRC’s cobalt mines?” this paper attempts to look at how the green energy revolution could be far less sustainable, when that word is considered in all its dimensions, than currently believed.

Background

The nature of the relationship between China and the African countries where it invests, such as the DRC, has been characterized by these respective countries as win-win. China’s approach to international relations in Africa is centered in mutual respect through non-interference in state politics and issues while offering a consistent stream of foreign direct investment (FDI). In return, African nations such as the DRC offer a slew of natural resources and host Chinese enterprises. In theory, this exchange is win-win. In reality, historian Claude Kabemba raises the burning question “how can a win-win partnership be realized between very unequal partners?”⁴

A better characterization is obligate symbiosis, meaning that rather than “win-win” these countries actually need each other to survive. China requires the DRC’s strategic mineral reserves to power its green economy and a growing battery and automobile export industry,

⁴ Claude Kabemba, “China-Democratic Republic of Congo relations: from a beneficial to a developmental cooperation,” *African Studies Quarterly* 16, no. 3-4 (2016): 73.

while the DRC requires China's investments to aid in the development of infrastructure post-colonialism and post-war. Particularly, China offers the opportunity to help boost the economy, fund and execute infrastructure and technology development, as well as strengthen public-private sector partnerships.⁵ In reality, the execution of this development has been stymied by weak government institutions in the DRC and resource-backed loans that favor Chinese actors.

Before the relationship between China and the DRC was defined by a thirst for resources, China approached the DRC as a non-Western or non-Soviet option for collaboration in a time of Cold War tension. The DRC has embraced Chinese relations since before its liberation from Belgium on June 30, 1960. In spite of poverty and internal strife at the time of the cultural revolution, China supplied resources to the DRC to fight Belgian colonial power for freedom.⁶ Soon after the DRC achieved independence, the process of formal diplomatic relations with China began, though these have wavered from time to time.⁷ Despite peaks and valleys in their relationship, the DRC saw an opportunity for growth and development away from the colonial nature of the West and totalitarian nature of the Soviets with China.

After the DRC's liberation, a presidential government was installed with hopes of elevating the minerally rich country to superpower status with Patrice Lumumba as prime minister and Joseph Kasavubu as president. While the successful ousting of Europeans from the DRC provided a glimmer of hope, symptoms of colonization such as corruption and violence have plagued the DRC since liberation. Shortly after his appointment, internal violence flared, resulting in the dismissal and murder of Lumumba.⁸ Following this period, Moise Tshombe was

⁵ Ibid., 74.

⁶ Ibid., 76

⁷ Philippe Tunamsifu Shirambere, "The Democratic Republic of the Congo-China's Deals in Construction in Exchange of Mines," *Afrika Focus* 33, no. 2 (2020): 80.

⁸ "Democratic Republic of Congo profile - Timeline," BBC News, January 10, 2019.

appointed as prime minister, but as a result of widespread dissent in 1965, Joseph Mobutu (Mobutu Sese Seko) installed himself as dictator and renamed the country Zaire. Through this, he continued building a relationship with the People's Republic of China, traveling there multiple times and receiving gifts from the Chinese such as "stadiums, hospitals, and other buildings."⁹ Mobutu ruled until 1997 when he was ousted by Laurent Desire-Kabila. In 2001, after the assassination of his father Laurent Kabila, Joseph Kabila became the head of state. Joseph Kabila had previously "trained at the People's Liberation Army National Defense University in Beijing..."¹⁰ and would go on to maintain a close working relationship with the Chinese in his years as president.

In 2006, Joseph Kabila won the first ever internationally recognized free presidential election in the DRC when he was re-elected.¹¹ Soon after, Joseph Kabila drafted his Cinq Chantiers (five pillars of development in the DRC) which included "infrastructure, job creation, education, water and electricity, and health."¹² Following a corruption scandal, Felix Tshisekedi became president in 2019. His presidency thus far has been characterized by a weak and ineffective posture which is perpetuating continued violence and poverty.¹³

Since the DRC's independence from Belgium, Congolese politics have been defined by tumult and corruption. Throughout the violence, human rights abuses, and corruption, Chinese interest and solidarity with Congolese politicians has generally remained steadfast, while Congolese relations with the West have faltered. This is in part because traditionally, Western

⁹ David Landry, "The risks and rewards of resource-for-infrastructure deals: Lessons from The Congo's Sicomines agreement," *Resources Policy* 58 (2018): 167.

¹⁰ *Ibid.*, 165

¹¹ BBC, "Democratic Republic of Congo Profile - Timeline," BBC News, January 10, 2019.

¹² Landry, "The risks and rewards of resource-for-infrastructure deals: Lessons from The Congo's Sicomines agreement," 165

¹³ Gaius Kowene, "Has Felix Tshisekedi Tackled DR Congo's Six Biggest Problems?" BBC News, January 24, 2020.

values such as democracy and human rights are at the forefront of Western international ventures. In contrast, Chinese foreign policy deemphasizes democracy and human rights, instead placing economics and non-interference at the vanguard of its international relations.

This difference can be further understood as the concept of “Chinese exceptionalism,” coined by Chris Alden of the London School of Economics and Daniel Large of Central European University. This term has been used to explain the relationship that China uses to engage with a variety of African countries which is “understood as a normative modality of engagement that seeks to structure relations such that, though they may remain asymmetrical in economic content they are nonetheless characterised as equal in terms of recognition of economic gains and political standing (mutual respect and political equality).” This approach is unique to a Chinese perspective of balancing power. Here, a focus on profit over moral or political agenda is perpetuated. In addition, such exceptionalism is distinct to Chinese foreign policy as it promotes “political principles based on a stronger conception of state sovereignty, non-interference, territorial integrity and political equality.”¹⁴ China’s exceptional methods of conducting international relations are extremely apparent in the way it interacts with African nations. This is exemplified in the case of the DRC.

DRC Context

The majority of the DRC’s economy is derived from its natural capital including its extraction, forestry, and agriculture industries. The World Bank defines natural capital as “the

¹⁴ Chris Alden and Daniel Large, “China's Exceptionalism and the Challenges of Delivering Difference in Africa,” *Journal of Contemporary China*, vol. 20, no. 68 (2010): 21.

stocks of natural resources, land, and ecosystems, it constitutes a more fundamental form of capital than man-made capital ... since it provides the basic conditions for human existence, biodiversity, food, clean water, and air, as well as essential resources.”¹⁵ The DRC is home to the world’s second largest rainforest and extensive mineral reserves meaning that it is one of the richest countries in terms of natural resources.

This “richness” solely considers the intrinsic projected value of its natural resources with an estimated value of \$24 trillion.¹⁶ That being said, the DRC is one of the poorest countries in terms of GDP per capita, at \$577.2 USD in 2021. Of the 95 million people living in the DRC, 64% of them live on less than \$2.15 per day in extreme poverty.¹⁷ With the contrast between extreme wealth and extreme poverty in the DRC, civil unrest is unsurprising. Numerous conditions have created this disparity including, but not limited to, the asymmetric power structures left over from colonization rooted in ethnic differences which have contributed to violence and unrest.

This unrest and corruption contributes to the rampant poverty of the average Congolese person. The DRC ranks 180 out of 191 ranked on the UN’s Human Development Index which is “a summary measure of average achievement in key dimensions of human development.” The HDI finds that in the DRC in 2021, life expectancy was 59.2 years and expected years of schooling was 9.8.¹⁸ It should however be noted that there are regional differences as the east of the country has been war-torn for decades while the west has experienced less violence.

¹⁵ Harouna Kinda and Noel Thiombiano, "The effects of extractive industries rent on deforestation in developing countries," *Resources Policy*. 73 (2021): 1.

¹⁶ “Instability in the Democratic Republic of the Congo,” Center for Preventative Action, Council on Foreign Relations, February 17, 2023.

¹⁷ “The World Bank in DRC,” World Bank, October 11, 2022.

¹⁸ “Human Development Index,” Human Development Reports- United Nations Development Programme, January 23, 2023.

As a developing nation, many people are employed by and depend on the primary sector. In the DRC, there is a strong emphasis on agriculture such as the production of coffee, cassava, rice, peanuts, sweet potatoes, chicken, cattle, pigs, forestry, and mining. 75% of the labor force is employed by agriculture and forestry with a growing number transitioning to mining. These industries represent 40%¹⁹ and 30% of the DRC's GDP respectively.²⁰ Such numbers are indicative of a developing economy with few employment opportunities in secondary and tertiary sectors. For now, the focus of the average Congolese is to find a way to feed their families which means working in the primary sector.

The DRC's strategic mining reserves characterize it as a pivotal actor in the green energy revolution. In regards to minerals, the DRC has abundant reserves of copper, cobalt (note that copper and cobalt are often found together therefore mines are copper/cobalt mines), zinc, cassiterite, manganese, coal, silver, cadmium, germanium, gold, palladium, uranium, platinum, coltan, wolframite, beryl, mozanite, methane, carbonic and nitrogen natural gasses, iron ore, diamond, bauxite, petroleum, and limestone.²¹ Katanga, one of the DRC provinces, is located in the southeast of the country and abundant in strategically important resources such as cobalt and copper. Additionally, the Kivu province hosts a plethora of natural resources and specifically cobalt.* This is visualized in Map 1 which highlights mining permits containing cobalt vs. other minerals and Map 2 which shows cobalt mining permit's relationships to the DRC's provinces.

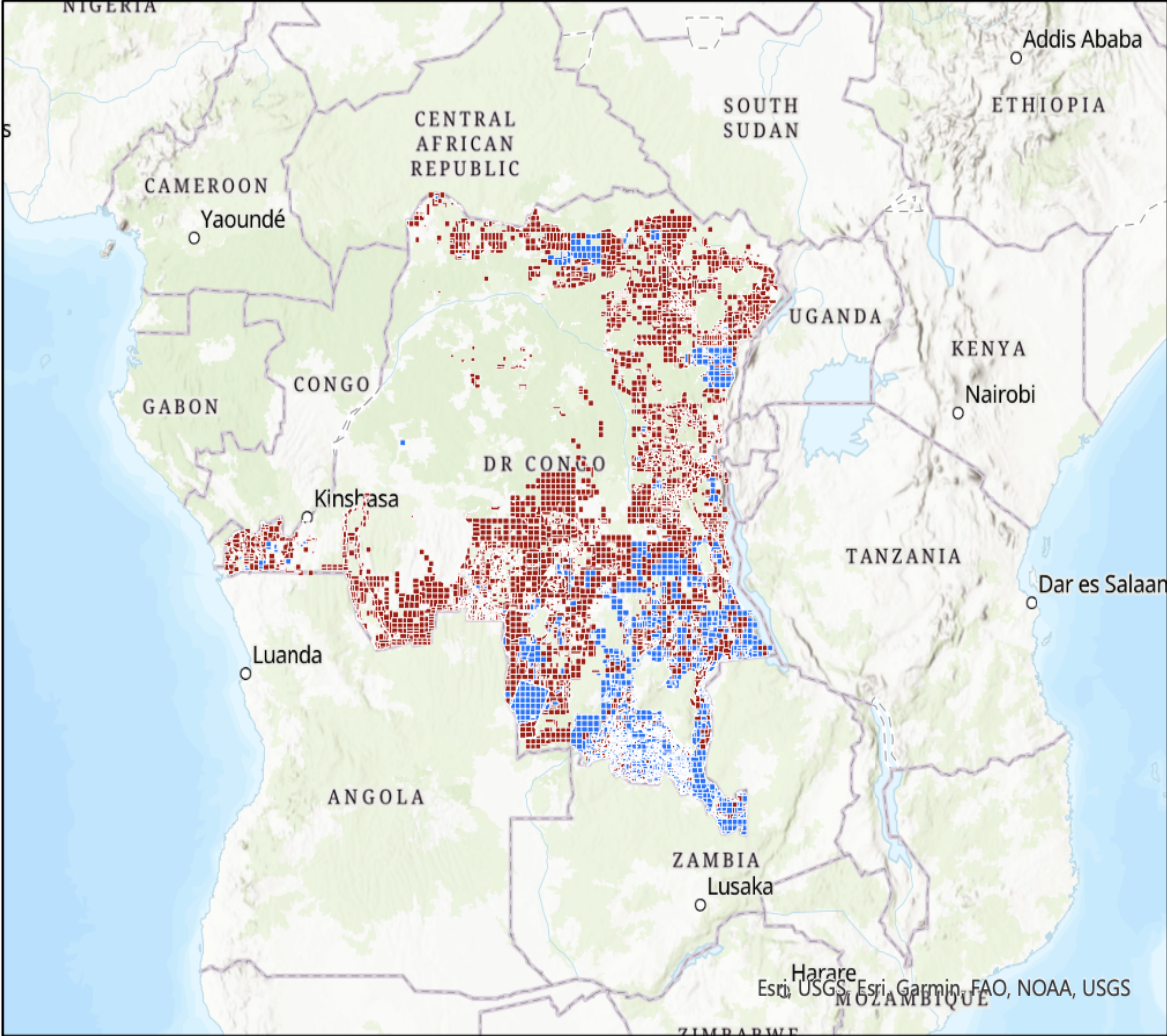
¹⁹ "Democratic Republic of the Congo," Encyclopædia Britannica, inc. Accessed March 28, 2023.

²⁰ Chloe Brown, Doreen S. Boyd, and Siddarth Kara, "Landscape Analysis of Cobalt Mining Activities from 2009 to 2021 Using Very High Resolution Satellite Data (Democratic Republic of the Congo)," *Sustainability* 14 (2022): 2.

²¹ "Democratic Republic of the Congo," Encyclopædia Britannica, inc.

*Note that provinces have been redistricted in the past 5 years and these have new names now but for the purposes of this paper I will use historic names.

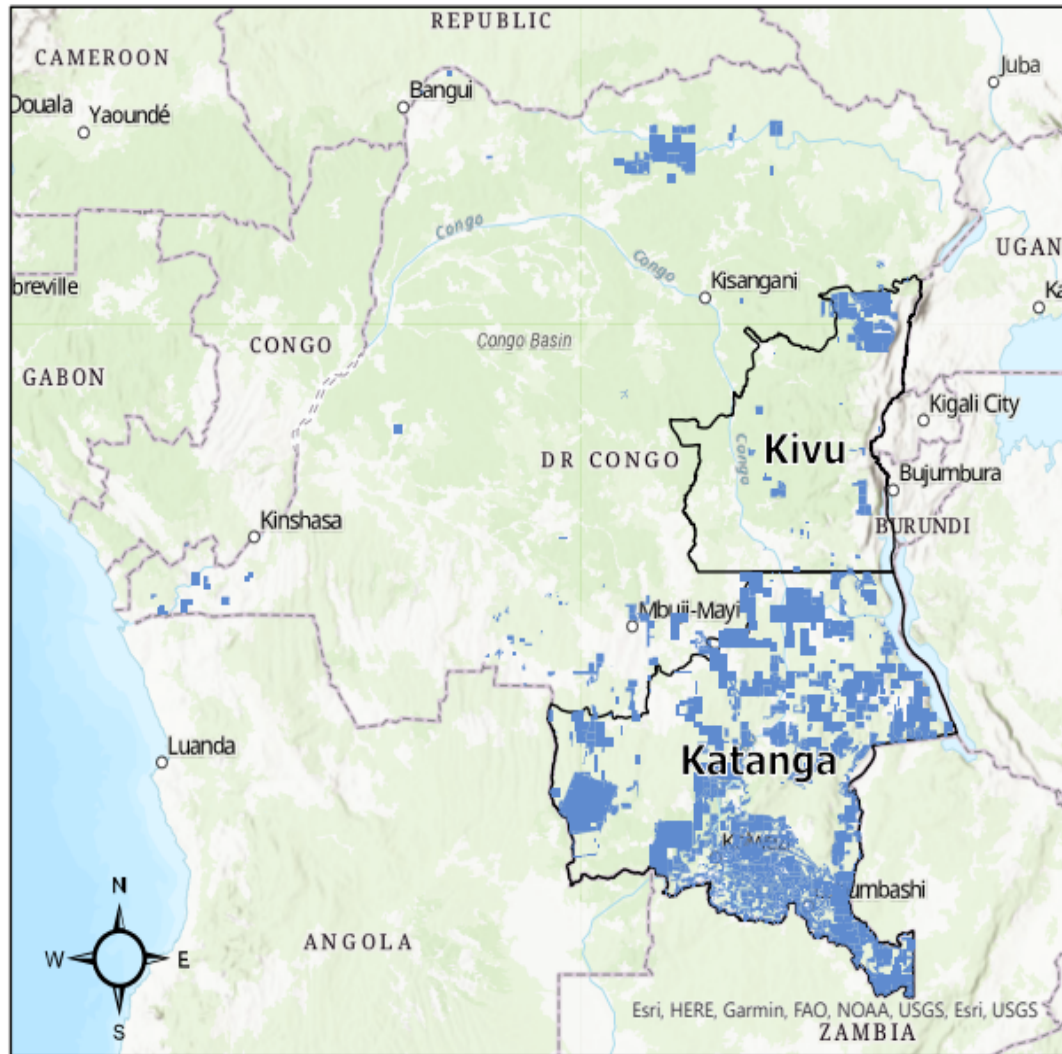
Map 1: Cobalt Mining Permits Across Provinces



- Cobalt Mining Permits
- DRC Mining Permits

Caroline Mallory, Feb. 25, 2023
Data Source: Global Forest Watch - Democratic Republic of the Congo Mining Permits
Projection: WGS 1984

Map 2: DRC Mining Permits Highlighting Cobalt





0 100 200 400 Miles

Caroline Mallory, March 10, 2023

Data Source:

Mining Permits: Global Forest Watch - Democratic Republic of the Congo Mining Permits

Provinces: GADM (2015)

-  Cobalt Mining Permits
-  Mining Provinces

Katanga is bordered by Angola, Zambia, and Tanzania across Lake Tanganyika. Its geography, culture, and natural resources are the richest on earth though people here live in extreme poverty. Here, ethnic tensions between Luba, Pygmies (Batwa), and Tutsis have flared on and off for decades.²² Largely attributed to colonization and following wars, this violence inhibits Congolese from reaching their full potential in terms of age, education, and quality of life. That said, Katanga has the greatest deposits of cobalt in the DRC which has led to recent rapid industrialization to facilitate mining.

Kivu borders Burundi, Rwanda, and Uganda and is home to numerous ethnicities. The rich diversity in Kivu has unfortunately led to longstanding conflict. Here, the First Congo war, the Second Congo war, Kivu conflict, and ongoing flares of violence related to ethnic tensions from the military and various rebel militia groups have erupted.²³ Conflict has persisted off and on since 1996 resulting in an estimated 5.4 million deaths as of 2010.²⁴ Armed militias and warlords control cobalt and other mines in Kivu. This unstable situation, in addition to a large foreign mining presence, has created dangerous working conditions and threatened Kivu's supply chains.²⁵

The large scale of violence and unrest in minerally rich provinces help reinforce the hypothesis of the Resource Curse which theorizes that the discovery of natural resources will have an adverse effect on the politics and economy of a country. It predicts that countries falling under the categorization of resource rich are more likely to have authoritarian governments, create continuing internal conflict, promote "inefficient spending and borrowing," contribute to

²² "DR Congo: Ethnic Militias Attack Citizens in Katanga," Human Rights Watch, August 11, 2015.

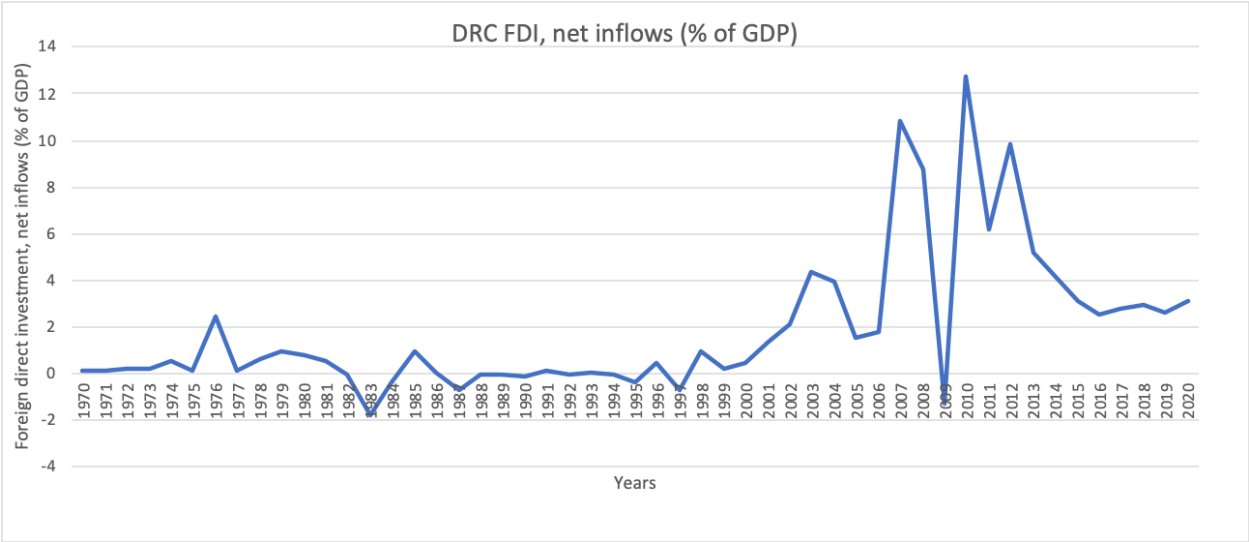
²³ "Instability in the Democratic Republic of the Congo," Center for Preventative Action, Council on Foreign Relations, February 17, 2023.

²⁴ "Review of Congo War Halves Death Toll," NBCNews.com, NBCUniversal News Group, January 20, 2010.

²⁵ Erik Grossman, Ending the Curse in the DRC: A Game of Thrones, Mines, and Militias," Small Wars Journal, September 13, 2018.

negative treatment of women, stifle public benefits, contribute to the “weak institutional development,” and have problems in the social and environmental sectors.²⁶ Despite the domestic issues faced by the DRC, its resources are too important to overlook. China has capitalized on the cheap strategic minerals and weak power structures to have a hand in controlling 80% of the country's cobalt through its historical ties to the DRC.²⁷ This can be better understood by considering Figure 1 which shows FDI in the DRC as a percentage of GDP. Interestingly, the period of 2006-2010 is when China and the DRC reached a significant resources-for-infrastructure deal called Sicominex.

Figure 1: DRC FDI Net Inflows (World Development Indicators, World Bank)



²⁶ “The Resource Curse: Understanding the Challenges and Opportunities for Resource-Dependent Countries,” Natural Resource Governance Institute, 2015.

²⁷ Chen, “Chinese in Beijing Manage Cobalt Mines in Africa by Remote Control: Study.”

Figure 2: Global Cobalt Deposits > 47,000 MMT

Country	DRC	Australia	Indonesia	Cuba	Philippines	Russia	Canada	Madagascar	China	USA	PNG
Cobalt reserves, million metric tons	3,500,000	1,400,000	600,000	500,000	260,000	250,000	220,000	100,000	80,000	69,000	47,000

Map 3: Global Deposits of Cobalt > 47,000 MMT



Caroline Mallory, Feb. 3, 2023
 Data Source: US Geological Survey- Mineral Commodity Summaries 2022
 Projection: WGS 1984

Esri, FAO, NOAA, USGS, Esri, USGS

Chinese Context

In the 1980's Deng Xiaoping brought forth the Four Modernizations which aimed to trigger development projects in China following the devastating impacts of Mao's cultural revolution in the sectors of agriculture, industry, science/technology, and defense. Since the introduction of the Four Modernizations, China has undergone a massive energy transformation.²⁸ China's industrial explosion in the 1990's under Deng Xiaoping's free market vision has led to one of the fastest-growing economies and societies in history.²⁹ This phenomena has lifted millions out of poverty, but has also presented unique challenges at an extreme scale. The growing population and economy exploded the middle class, requiring vast resources to fit with their new quality of life. In the last 45 years, China has gone from a famine-struck, closed-market society to a wealthy, powerful, and influential nation. However, China is not endowed with large deposits of crude oil or natural gas, but instead, has large deposits of coal. Increasing demand for energy in China has required the nation to use large amounts of coal and imported foreign oil and gas, making them the world's largest consumer of energy and emitter of carbon.³⁰

Since 1965, Chinese energy usage per capita has increased from 7.6 to 109.1 gigajoules per capita in 2021; a 14-fold increase in merely 56 years.³¹ While China has an aging population, its energy supply issue remains significant especially in light of its climbing GDP per capita. From 2010-2020, China's population grew by almost 5% while its GDP grew over 43%.³² This presents an issue of demand for energy intensive commodities such as ovens, refrigerators, and

²⁸ "Four Modernizations," Encyclopedia Britannica, Accessed March 4, 2023.

²⁹ "The Fastest-Growing Economies in the World," World Economic Forum, June 22, 2015.

³⁰ "CO2 Emissions," Global Carbon Atlas, Accessed March 31, 2023.

³¹ "Statistical Review of World Energy," British Petroleum Co. 2021.

³² "China Population Growth Rate 1950-2021," Macrotrends, 2021.

cars. In a country of 1.4 billion, the consequence of a GDP increase of over 200% in the last ten years is energy demand and pollution. This issue will only get exponentially worse as GDP per capita grows.

The explosion of the Chinese has been nothing short of outstanding since Deng Xiaoping's vision which sought to "pursue an open-door policy, in which it adopted a stance to achieve economic growth through the active introduction of foreign capital and technology while maintaining its commitment to socialism."³³ China instituted reforms to open the country economically while maintaining a communist government. Since 2021, the Chinese economy has grown to \$17.73 trillion USD thanks to these efforts.³⁴

With this fantastic growth, a fantastic problem is also presented: pollution. For decades, impacts of Chinese production on the environment were not considered and the extent of its damages was unknown. However, now they are unavoidably obvious. Extensive detrimental issues have arisen because of this notorious pollution "including outdoor and indoor air pollution, water shortages and pollution, desertification, and soil pollution."³⁵ In addition to environmental damages, human health has suffered greatly because of high GHG emissions. Peaking in 2013, air pollution in China has resulted in around 1.25 million early deaths per year. In 2020 "the air breathed by 81% of China's population ha[d] yet to meet the first interim target" of WHO global guidelines for air pollution.³⁶ Pollution in China has been tied to "lung cancer, acute respiratory infection, and chronic obstructive pulmonary disease." One of the most significant manifestations of this pollution is in water sources. It was found that "exposure to

³³ Shigeo Kobayashi, Jia Baobo, and Junya Sano, "The 'Three Reforms' in China: Progress and Outlook." *Sakura Institute of Research, Inc.*, September 1999.

³⁴ World Bank, "GDP (current US\$) - China," Accessed March 4, 2023.

³⁵ Haidong Kan, "Environment and Health in China: Challenges and Opportunities," *Environmental Health Perspectives* 117, no. 2 (2009): A530.

³⁶ Gary Fuller, "Pollutionwatch: air pollution in China falling, study shows," *The Guardian*, September 10, 2020.

contaminated drinking water has been associated with increasing rates of digestive cancers and infectious diseases such as hepatitis and cholera.”³⁷ Additionally, the fiscal cost from pollution is drastic as evident in 2019 with a \$9 billion increase in health spending from pollution related conditions.³⁸ These expensive issues stemming from pollution have forced China to reconsider where it gets energy and how it uses it.

The Green Energy Revolution

In the last century, the impact of humans on our environment has become very apparent, forcing us to find creative solutions to numerous environmental problems including climate change. The extraction and burning of carbon-releasing energy sources is unsustainable and costly to the economy and environment. Unlearning using these sources and finding new ones takes valuable time.

However, time is of the essence. As climate change is a supranational problem, the United Nations has been an organizing voice for fighting climate change along with other NGOs. Secretary-General Guterres summed up the gravity of the problem at hand saying that “the only true path to energy security, stable power prices, prosperity and a livable planet lies in abandoning polluting fossil fuels and accelerating the renewables-based energy transition.”³⁹ Accelerated by the crippling effects of the Russian invasion of Ukraine on the energy grid, the importance of transitioning to green energy has never been more important.

³⁷ Kan, “Environment and Health in China: Challenges and Opportunities.”

³⁸ Panle Jia Barwick, Shanjun Li, Deyu Rao, and Nahim Bin Zahur, “The Impact of Air Pollution on Healthcare Spending in China,” VoxDev, April 18, 2019.

³⁹ Antonio Guterres, “The World Is Burning. We Need a Renewables Revolution,” United Nations, June 27, 2022.

According to the Intergovernmental Panel on Climate Change, burning fossil fuels in high amounts is the cause of the climate crisis.⁴⁰ This emergency calls for a green energy revolution - a rapid advancement of research, development, and implementation of green energy sources to transition from carbon-emitting energy sources. The EPA defines green power as “renewable energy resources and technologies that provide the greatest environmental benefit.”⁴¹ Nations rich in minerals necessary for green energy technologies, such as the DRC, could hold the answer to powering green energy. China already has the jump on securing these finite and irreplaceable mineral resources in the DRC to transition itself to green energy.

The DRC is home to the majority of the world’s cobalt reserves which is a critical component in lithium ion batteries used in EVs as well as other rechargeable devices and in some industrial processes. In 2020, 64% of mined cobalt was utilized to manufacture lithium-ion batteries.⁴² Cobalt is also utilized in wind turbine manufacturing and oil refining to reduce emissions. These technologies are pivotal to transitioning to renewable energy sources to limit temperature and climate change. Considering these benefits and the new urgency to participate in the green energy revolution, the Cobalt Institute, a body promoting the sustainable use of cobalt through knowledge and research, projects demand for cobalt to rise 13% a year for the 5 years following 2021 after a 22% increase in demand in 2021.⁴³

In an effort to command the EV market and produce other goods using cobalt such as rechargeable batteries in phones, tablets, laptop computers, and other industrial objects, China

⁴⁰ IPCC, “The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change,” Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, 2021.

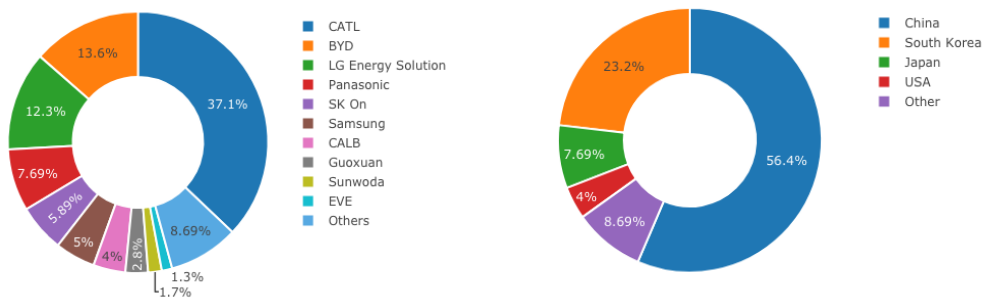
⁴¹ “What is Green Power?” United States Environmental Protection Agency, Accessed April 17, 2023.

⁴² Andrew Gulley, “One Hundred Year of Cobalt Production in the Democratic Republic of the Congo,” *Resources Policy* 79 (2022): 1.

⁴³ “Cobalt Market Report 2021,” Cobalt Institute, May 17, 2022.

has woven itself into the fabric of the DRC’s natural resource economy.⁴⁴ As the world’s factory, China has become the largest producer of EV batteries. Specifically, the Chinese company CATL (Contemporary Amperex Technology Co. Ltd.’s) accounted for 37.1% of EV battery sales in the first 11 months of 2022 globally according to Bloomberg.⁴⁵ To supplement this, other Chinese producers such as BYD co. and South Korean companies also contributed to the market. Chinese EV battery producers make car batteries for G.M., Volkswagen, BMW, Tesla and other top car companies.⁴⁶

Figure 3: Battery pie charts



Bloomberg - Source SNE Research
 *EV battery sales between January and November 2022

In order to meet Western countries' demand for new EVs, China is in both a strategic and critical position in the green energy revolution. This position is reliant on a resilient and consistent supply chain of cobalt from the DRC. As such, command over the DRC’s cobalt is crucial. The unlikely relationship of the DRC and China holds the answer to China’s energy and

⁴⁴ “Cobalt Statistics and Information,” U.S. Geological Survey, Accessed March 28, 2023.
⁴⁵ Heejin Kim, “China's CATL Extends Lead as World's Top Electric-Car Battery Maker,” Bloomberg, January 4, 2023.
⁴⁶ Keith Bradsher and Michael Forsythe, “Why a Chinese Company Dominates Electric Car Batteries,” The New York Times, December 22, 2021.

pollution issues. For China, the DRC's natural wealth offers the ability to both produce energy domestically and with fewer emissions.

There is no doubt that cobalt is the mineral powering the green energy revolution. With both increasing supply and demand and falling price, lithium-ion batteries will be phased in to replace internal combustion engines. The DRC's natural resource deposits are integral to this transition which is why China has secured their position in the eastern DRC. While its long history of investment and interest in the DRC should be kept in mind, more recently China has utilized resource-backed lending when it comes to mining contracts. Resource-backed loans are used in cases where the borrowing country has low-credit and high-risk. These developing nations have limited access to traditional methods of capital in the international market, therefore turn to other means of procurement. Repayment of loans in a resource-backed contract is "made directly in natural resources, that is, in kind, or from a natural resource-related future income stream, or repayment is guaranteed by a natural resource-related income stream, or a natural resource asset serves as collateral."⁴⁷ While initially, the loans work well for both countries involved in the deal, over time, the developing nation may give up significant resource wealth.

The Sicomines Loans

Once referred to as "the deal of the century," the DRC and China worked to reach the Sicomines deal between 2006 and 2008; a resource-for-infrastructure (RFI) loan wherein there would be an exchange of \$6.2 billion USD for an estimated 10.6 million tons of copper and

⁴⁷ David Mihalyi, Aisha Adam and Jyhjong Hwang, "Resource-Backed Loans: Pitfalls and Potential: Executive Summary," Natural Resource Governance Institute, February 2020, 1.

626,619 tons of cobalt.⁴⁸ The Sicomines deal redefined China's role in not only the DRC, but the entire world. Resource acquisition by the Chinese Communist Party (CCP) in the early 2000's was a defining characteristic of the regime. In 2001, to proliferate their "Going Global" strategy, China looked to invest in foreign markets to diversify their economy and gain influence abroad.⁴⁹ Noticing the absence of key strategic minerals such as copper and cobalt, China sought investment opportunities in the DRC. Following the end of "Africa's world war" (commonly known as the Second Congo War), a violent 5-year war involving the DRC, Angola, Namibia, Zimbabwe, Rwanda, Uganda and various non-state actors, the DRC was in extreme need of basic infrastructure.⁵⁰ Both China and the DRC had what the other needed: resources for infrastructure.

China would provide a line of credit to finance infrastructure development for \$3 billion USD with the remaining \$3.2 billion to be invested into Sicomines mines at a 4.4% interest rate.⁵¹ The deal was signed by President Joseph Kabila in 2008 with hopes of stimulating the economic potential of the DRC's natural resources. Shortly after the deal was signed, it was identified by the IMF that this "would straddle the DRC with unsustainable debt" as the country was already in need of \$10 billion in debt forgiveness from the IMF.⁵² As such, the IMF reached an agreement with the parties to reduce the infrastructure loan to \$1.053 billion with an additional \$3.2 billion to be invested in the mine itself. Note that in a report by Congolese

⁴⁸ Triston Columa, "Quand Le Fleuve Congo Illuminera L'Afrique , Le 'Contrat Du Siècle.'" *Le Monde diplomatique*, February 1, 2011.

⁴⁹ Johanna Jansson, "The Sicomines Agreement Revisited: Prudent Chinese Banks and Risktaking Chinese Companies," *Review of African Political Economy* 40 (2013): 154.

⁵⁰ Andoni Maiza-Larrarte and Gloria Claudio-Quiroga, "The Impact of Sicomines on Development in the Democratic Republic of Congo," *International Affairs* 95, no. 2 (2019): 423–446.

⁵¹ Maiza-Larrarte and Claudio-Quiroga, "The Impact of Sicomines on Development in the Democratic Republic of Congo," 423–446.

⁵² Landry, "The Risks and Rewards of Resource-for-Infrastructure Deals: Lessons from the Congo's Sicomines Agreement," 168.

Agency for Major Works, since November of 2019, only \$800 million has been invested in the DRC's infrastructure thus far.⁵³

Four players were involved in this initial deal; the Congolese government, the Chinese government, China's EXIM bank (export-import bank), and private Chinese companies. To facilitate the exchange of cash for resources, the Sicomines joint venture was created. Here, Chinese companies would get a 68% stake (China Railway Group Ltd. 27%, Sinohydro Corporation Ltd 26%, China Railway Resources Development Ltd. 6%, Zhejiang Huayou Cobalt Company Ltd. 5%, Sinohydro Harbour Company Ltd. 4%) and the DRC's state mining company Gécamines would get a 32% stake in the Sicomines joint venture mining company. In exchange for the majority stake in the joint venture and \$3.2 billion USD, the aforementioned Chinese companies were contracted to construct "3500 km of roads, as many kilometers of railways, road infrastructure especially in Kinshasa, 31 hospitals of 150 beds and 145 health centers – with an estimated value of \$6.5 billion" according to the original deal.⁵⁴

The resource-backed agreement is split into three phases. First, the profits from the Sicomines joint venture mining go to repay the Eximbank loans. This money is going back into the vault of China's foreign investment bank while China is simultaneously profiting off of the production of goods made using copper and cobalt extracted in these mines. Secondly, once those have been reimbursed, 85% of Sicomine's profits will repay the loans from the Chinese joint venture companies. This money will go back to the private businesses investing in Sicomines. These are China Railway Group Ltd., Sinohydro Corporation Ltd., China Railway Resources Development Ltd., Zhejiang Huayou Cobalt Company Ltd., Sinohydro Harbour

⁵³ Shirambere, "The Democratic Republic of the Congo-China's Deals in Construction in Exchange of Mines," 89.

⁵⁴ Triston Columa, "Quand Le Fleuve Congo Illuminera L'Afrique , Le 'Contrat Du Siècle.'" *Le Monde diplomatique*, February 1, 2011.

Company Ltd. as aforementioned. Additionally, the balance of the original \$3 billion will be accessible during phase two. Finally, after those loans have been repaid, Sicominex will start paying taxes to the Congolese government on the resources extracted. Originally quoted for a 25-year repayment period, almost all profits from Congolese minerals on the market would go into the pockets of Eximbank and the Chinese joint venture companies.⁵⁵ While there is no evidence that the Sicominex deal was executed with malicious intent, the outcome has taken advantage of the Congolese people and their environment. The situation with the Sicominex deal between China and the DRC goes to confirm DRC Environmental Governance expert and researcher Theodore Trefon's hypothesis "that mineral wealth benefits a small cluster of political and military elites and foreign companies but hardly contributes to national development."⁵⁶ Unfortunately, the tide is not changing here in the DRC anytime soon with the unrealistic quarter-century repayment period.

Despite the good intentions (at least on paper) to provide vital infrastructure to a crippled nation, the Sicominex loans have faced various sources of criticism. Firstly, Bloomberg's William Clowes identifies that "there has always been a quite considerable lack of transparency around the Sicominex project."⁵⁷ Finding clear information on the history of the deal and what has been implemented so far is difficult. Another important source of criticism is a stipulation in the agreement wherein Chinese companies are exempt from paying taxes or royalties on extracted copper and cobalt. Until the loans have all been paid back, the DRC's only real benefit from the extraction of these resources is upfront infrastructure investment. The absence of these taxes is detrimental to the DRC's economy and this agreement has been characterized as having

⁵⁵ Landry, "The Risks and Rewards of Resource-for-Infrastructure Deals: Lessons from the Congo's Sicominex Agreement," 168.

⁵⁶ Theodore Trefon, *Congo's Environmental Paradox* (London: Routledge, 2016), 123.

⁵⁷ Bloomberg Originals, "How Chinese Cash Flowed to Congo's Former First Family," April 26, 2022, 6:35-6:45.

“unconscionable character” according to Congolese consultants.⁵⁸ It is also interesting to note that in 2008, China’s GDP was \$4.59 trillion USD, making their ~\$4.25 billion resource-backed loans 0.09% of their GDP in 2008.⁵⁹ This shows that while this was the deal of the century for the DRC, there was little risk on China’s behalf. Additionally, according to Business Wire, in 2021 China exported 3.427 billion lithium-ion batteries valued at \$28.423 billion dollars. This is important to contextualize as China benefits from the DRC’s cobalt mining industry while the DRC will still be in debt for years to come. This debt could be paid off with less two months of total sales from lithium-ion batteries exported by China.⁶⁰

Finally, considerable corruption of former president Joseph Kabila and his family and inner circle exposed in the Congo Hold-Up leak, a leak of financial documents surrounding the activities of the private bank Groupe BGFIBank S.A. and the Kabila family, revealed that the funds dedicated for public development were compromised and funneled into the Kabila family’s personal accounts and businesses.⁶¹ This includes but is not limited to Chinese development money that went through an intermediary, but wound up with the Kabila family.⁶²

While the hopes for the Chinese-Congolese mining corporations were high to both expedite the production of green energy technologies and for the economy of the DRC, the effects have been less impressive for the latter. GDP has increased slightly in the DRC from \$19.79 billion USD to \$53.96 billion USD⁶³ and GDP per capita increased from \$328 USD to \$584 USD respectively from 2008-2021.⁶⁴ The expectations for the RFI loan were high for the

⁵⁸ Aaron Ross and Helen Reid, “Congo's \$6 Bln China Mining Deal 'Unconscionable', Says Draft Report.” Reuters, October 8, 2021.

⁵⁹ “GDP (current US\$),” World Bank, Accessed April 17, 2023.

⁶⁰ “Research Report on China's Lithium-Ion Battery Export Industry, 2023-2032,” Business Wire, January 19, 2023.

⁶¹ William Clowes and Michael Kavanagh, “Document Leak Shows Kabila Family, Associates Looted DRC Funds,” Al Jazeera, November 19, 2021.

⁶² Bloomberg Originals, “How Chinese Cash Flowed to Congo’s Former First Family,” April 26, 2022, 9:25-9:37.

⁶³ “Congo GDP,” Trading Economics, 2022.

⁶⁴ “Democratic Republic of Congo GDP per Capita 1960-2023,” Macrotrends, 2023.

future, though unexpected costs attributed with the project and an unrealistic repayment timeline could do more harm than good. Andoni Maiza Larrate of Universidad del Pais Vasco and Gloria Claudio-Quiroga of Francisco de Vitoria University in Madrid raise a moral concern with the Sicomines loan and RFI loans in general saying that the deal “never included any guarantee of the actual value that the Congolese population would get in exchange for the country’s main source of wealth.”⁶⁵ The extraction of the copper and cobalt from Sicomines has not only adversely impacted the past, present, and future outlook for the economy of the DRC, but attention should be equally focused on the human rights and environmental offenses that are taking place in connection to Sicomines.

Human Rights

When looking at cobalt mining in the DRC, it is important to distinguish between the two types. First, there are commercial industrial mines. These mines are owned by giants such as Switzerland’s Glencore and China’s China Molybdenum. These mines take on the format of open pits using drill and blast methods. In addition to manpower, commercial mines use wheel loaders, hydraulic excavators, front loaders, and dump trucks.⁶⁶ In the DRC, these enterprises are operated mostly by foreign conglomerates who negotiate mining contracts from the DRC’s government. In some cases, such as the Tenke Fungurume mine in the most important copper-cobalt mining town Kolwezi, mines are owned in part by foreigners and in part by Gécamines. In this case, 80% of the Tenke Fungurume mine is owned by China Molybdenum and 20% is

⁶⁵ Maiza-Larrarte and Claudio-Quiroga, “The Impact of Sicomines on Development in the Democratic Republic of Congo,” 423–46.

⁶⁶ “Major Mines & Projects: Tenke Fungurume Mine,” Mining Data Online, Accessed March 28, 2023.

owned by Gécamines. The discovery of cobalt in the Kolwezi district in the southeastern DRC has drawn the attention of not only foreign companies seeking to imprint on the African economy and increase their mineral security, but also Congolese people.

Many individuals looking to provide for their families decide to work in artisanal mines which are generally located on the outskirts of the commercial mines. Artisanal mining is informal, small-scale mining with little equipment. This kind of mining attracts a crowd with lesser ability to participate in the formal economy. These include but are not limited to children, mothers, and undereducated persons. Such mining is associated with child labor and the exploitation of impoverished people. Miners in artisanal mines are called “creuseurs” which translates to “diggers” in French. Creuseurs work around the commercial mines as well as in neighborhoods with known deposits searching for cobalt. Artisanal mining is legal according to DRC law when it happens within designated zones and is part of an approved cooperative.⁶⁷ Trespassing, child labor, and dangerous working conditions fall outside of the law’s framework, but are commonly accepted as “artisanal mining provides direct livelihood to approximately 1.2 million ‘creuseurs,’ which implies that some 10 million people indirectly benefit from this activity” according to Banza Lubaba Nkulu et al.⁶⁸ Artisanal cobalt mining is estimated to make up 20% of the cobalt mined in the DRC meaning this industry is necessary to the country’s cobalt supply chain.⁶⁹

Concerns with the supply chain of cobalt have been raised for years as the cobalt mined from both commercial and artisanal mines ends up mixed when it is collected and shipped out for

⁶⁷ Agence France-Presse, “DRC’s Illegal Mining Dilemma.” VOA Africa, November 2, 2022.

⁶⁸ Célestin Banza Lubaba Nkulu *et al.* “Sustainability of artisanal mining of cobalt in DR Congo.” *Nat Sustain* vol. 1, (2018): 501.

⁶⁹ Michelle Fabiola Lawson, “The DRC Mining Industry: Child Labor and Formalization of Small-Scale Mining,” Wilson Center, September 1, 2021.

processing.⁷⁰ Dorothee Baumann Pauly, director of the Geneva Center for Business and Human Rights argues that it is “virtually impossible” for manufacturers to completely exclude artisanal cobalt from production. Generally, cobalt is smelted in either China or the DRC which makes it difficult to govern and oversee where each piece of metal comes from.⁷¹ In a country with such economic precariousness, artisanal mining has become the livelihood for people and is an essential part of the DRC’s economy. That said, it is imperative to draw attention to the human rights issues that arise during cobalt mining in the DRC.

One such group facing abuse and exploitation in artisanal cobalt mines are children. The New Yorker shares accounts of children as young as three years old learning to identify and pick cobalt out of the ground.⁷² Reporting from The Wilson Center, an independent Washington D.C. think tank, estimates that “of the 255,000 Congolese who are cobalt miners, 40,000 [~16%] are children.”⁷³ For many children, education is not an option as school fees are out of reach for parents. Rather, in order to provide food for the family, children are relied upon to go to the mines.

In the larger context of child labor, the number of children participating in cobalt mining is concerning for many reasons. One is that this large scale employment of children takes away from their ability to attend school. Rampant child labor in the DRC could result in serious future implications for the make-up of the labor force. If such a large part of the population is excluded from obtaining an education, development will be arduous. Researchers Eric V. Edmonds and Caroline Theoharides find that child labor “dampers future economic growth through its negative

⁷⁰ Michael Posner, “To Meet Global Demand, Companies Must Reform Mining Practices in The Congo,” Forbes, February 10, 2023.

⁷¹ “Microsoft calls for ‘coalition’ to improve Congo’s informal cobalt mines,” Reuters, February 8, 2023.

⁷² Nicolas Niarchos, “The Dark Side of Congo’s Cobalt Rush,” The New Yorker, May 24, 2021.

⁷³ Lawson, “The DRC Mining Industry: Child Labor and Formalization of Small-Scale Mining.”

impact on child development and depresses current growth by reducing unskilled wages and discouraging the adoption of skill-intensive technologies.”⁷⁴ The short-term payouts of children’s participation in the economy are dwarfed by the long term payouts of a more educated workforce. If the DRC wants to capitalize on its economic potential, it is imperative that the government cracks down on child labor practices in cobalt mining and across other industries to decrease barriers for children to go to school.

In addition to the current and future economic impacts of the DRC’s dependence on child labor in the cobalt mining industry, another facet to consider is the human impact of child labor. The practice of child labor in the mines fundamentally opposes the UN High Commission for Human Right’s Convention on the Rights of the Child adopted in 1989. Most emphatically, the practice of child labor in the mines violates article 32 clause 1 which says “States Parties recognize the right of the child to be protected from economic exploitation and from performing any work that is likely to be hazardous or to interfere with the child's education, or to be harmful to the child's health or physical, mental, spiritual, moral or social development.”⁷⁵ This convention has been ratified by 195 countries including the DRC and excluding the United States and Somalia.⁷⁶ Artisanal cobalt mining breaches these aforementioned rights. The responsibility to uphold this article falls on the DRC and their feeble government institutions, but should also be assumed in part by the companies processing mixed commercial and artisanal cobalt. Though the Convention on the Rights of the Child has been in place for over thirty years, consistently poor governance and poverty are preventing it from being implemented in the DRC. That being

⁷⁴ Eric V. Edmonds and Caroline Theoharides, “Child Labor and Economic Development,” *Handbook of Labor, Human Resources and Population Economics*, November 18, 2021, 1.

⁷⁵ “Convention on the Rights of the Child,” Office of the United Nations High Commissioner for Human Rights, Accessed April 21, 2023.

⁷⁶ “The United Nations Convention on the Rights of a Child,” CRS Report R40484, Congressional Research Service, 2015.

said, more attention to this issue has been raised in the West as their reliance on cobalt has grown exponentially over the past decade.

While 195 countries have ratified article 32 which protects against child economic exploitation, the conditions in which child cobalt miners work violate several other rights. Children in the cobalt mines interviewed by Amnesty International discussed their experience, sharing that they work long hours ranging between 12-24 per day. One child, Paul, disclosed that he routinely spent 24 hours at a time in the mines saying that he “arrived in the morning and would leave the following morning.” This back-breaking work was on little to no food and all for a few dollars. In fact, another account from *The New Yorker*’s exposé shares that “children who work in the mines are often drugged, in order to suppress hunger.” Children also faced violence when trespassing on sovereign mining concessions of other companies. Many witnessed or experienced beating from security guards. Amnesty International argues that “the participation of children in mining is widely recognized as one of the worst forms of child labor.”⁷⁷

Unfortunately, this is not an uncommon experience for children living in the eastern DRC. This is in part because children are considered particularly valuable in the artisanal mining practice given their size. Many of the artisanal cobalt mines in the DRC are hand dug which generally means that they are quite small at a high risk for collapsing. The exploitation and hard labor of children in the cobalt mines of the DRC is extraordinarily appalling though other populations face considerable dangers too other than children.

Another population facing harms in artisanal cobalt mining is women. Given traditional gender roles, women generally do not participate in the actual extraction of the ore. Rather, they conduct “droumage” which involves crushing, sorting, and washing cobalt. This process results

⁷⁷ Niarchos, “The Dark Side of Congo's Cobalt Rush.”

in the exposure to extremely toxic waste. A 2016 report by Women's International League for Peace and Freedom titled *Life at the bottom of the chain: women in artisanal mines in DRC* interviewing women in Kambove, a town in Katanga known for mining, found that many women experienced menstrual disturbances, miscarriages, and yeast infections while children born with parents in the mining industry experienced higher rates of birth defects and malformation.⁷⁸

In addition to apparent health risks specific to women caused by their environment, women experience another physical risk working in the mines: men. Women in artisanal cobalt mining report facing sexual exploitation and violence in addition to there being high levels of child marriage. They also interviewed women in the mines about their exposure to sexual violence. 73.75 % of women in the mines experienced some form of sexual violence, though many were hesitant to answer given the subject matter. There is a high level of prostitution, especially by young girls, in the mines as the industry and towns where it exists is primarily male dominated. Lack of sex education and medical infrastructure results in high levels of sexually-transmitted diseases in mining zones. All in all, according to the Women's International League for Peace and Freedom report, of women interviewed, 71% reported that they feel unsafe in the mines.⁷⁹ Both children and women are being exploited in the cobalt mines, but everyone participating in the artisanal mining sector is impacted.

A nondiscriminatory danger facing both those involved in mining and those living in cobalt mining regions is the dust produced from mining. According to the CDC, the dust produced from the rampant copper-cobalt mining in these districts can cause the potentially fatal Hard Metal Lung Disease (HMLD). The disease is caused by prolonged exposure to the mining

⁷⁸ "Life at the bottom of the chain: women in artisanal mines in DRC," Women's International League for Peace & Freedom, 2018, 15.

⁷⁹ *Ibid.*, 17.

of metals such as cobalt and also copper and tungsten. Also identified as Cobalt Related Interstitial Lung Disease, this disease can be identified through both pulmonary and extrapulmonary symptoms. These include dyspnea, cough, fever, chills, weight loss and sore throat, nasal congestion, sneezing and potentially cancer.⁸⁰

After traveling to Katanga to experience the mines for themselves, Amnesty International discovered that the conditions of the mines left laborers with other chronic symptoms such as “coughing, pain in their lungs and urinary tract infections.”⁸¹ According to Mt. Sinai hospital, extended exposure and inhalation of cobalt dust could cause problems such as cardiomyopathy, deafness, nerve problems, ringing in the ears, thickening of the blood, thyroid problems, and vision problems.⁸² While the existence of cobalt mining in the eastern DRC is an essential part of livelihood, there needs to be better system in place to address health concerns associated with cobalt mining. The lack of medical infrastructure in the DRC means that many artisanal miners exposed to harmful toxins do not have proper protective equipment and cannot easily access support when facing sickness. The World Bank reports that according to the latest data in 2013, there are only 0.1 doctors for 1,000 people.⁸³ This means that the health risks associated with cobalt mining often go untreated.

In light of the human rights issues associated with cobalt mining in the DRC and the inevitable mixing of commercial and artisanal cobalt, Western companies have faced scrutiny over their supply chains. In 2019 the International Rights Advocates filed a lawsuit in the United States seeking damages over the deaths of child cobalt miners in the DRC on behalf of 14

⁸⁰ Traci N. Adams, Yasmeen M. Butt, Kiran Batra, and Craig S. Glazer, “Cobalt Related Interstitial Lung Disease,” *Respiratory Medicine* 129 (2017): 91–97.

⁸¹ “DRC: Alarming research shows long lasting harm from cobalt mine abuses,” Amnesty International, May 6, 2020.

⁸² “Cobalt Poisoning,” Icahn School of Medicine at Mount Sinai, Accessed March 28, 2023.

⁸³ “Physicians (per 1,000 people),” World Bank. Accessed April 17, 2023.

families. Two mining companies, Zhejiang Huayou Cobalt and Glencore were named in the lawsuit. The former is aforementioned as one of the private Chinese businesses investing in Sicomines (see pg. 22). Additionally note that “in 2017 [Zhejiang] Huayou controlled twenty-one per cent of the global cobalt market.” This scale of control means that Zhejiang Huayou could crack down on artisanal practices or at least mitigate some of the dangers of cobalt mining and make a significant difference for the livelihood of many Congolese. According to the BBC the families suing want compensation “for forced labour, emotional distress and negligent supervision.”⁸⁴ Two years later, the lawsuit was dismissed in the courts because “the plaintiffs did not have standing to bring their claims because they did not adequately identify the defendants’ conduct as the cause of the injury they suffered” according to Baker McKenzie.⁸⁵

Although media attention is ramping up in the West, changing practices in the DRC will likely not result from this. Motivated by money and fear of energy insecurity, Peter Zhou, a Chinese financier who works on cobalt deals in the DRC, said “there is corruption, there is lack of the rule of law, which gives you more autonomy to be entrepreneurial.”⁸⁶ This is the mindset of many actors looking to extract in the DRC.

Environmental Implications

Environmental degradation is another symptom of unsustainable cobalt mining in the DRC. Air, ground, and water pollution impacts those involved in the mining industry as well as those living in cobalt mining regions and along connected tributaries. Rethinking the label “clean

⁸⁴ “Top tech firms sued over DR Congo cobalt mining deaths,” BBC, December 16, 2019.

⁸⁵ Maria Piontkovska and Doriane Nguenang, “US Court Dismissed Cobalt Mining Forced Labor Lawsuit Against Tech Companies,” Baker McKenzie, November 18, 2021.

⁸⁶ Niarchos, “The Dark Side of Congo's Cobalt Rush.”

energy” is necessary when considering the process and consequences of cobalt mining in the DRC as there is a strong association with cobalt needed for clean energy technologies and environmental degradation.

After cobalt is extracted by miners in tunnels or pits in both commercial and artisanal mines, the ore is washed. Given the geography of the DRC, much of the ore is washed in rivers leading into the Congo river. Polluted water has the ability to spread far and wide. The Congo river, Africa’s second largest river at 2,900 miles, runs east to west from the south-east mining district through the capital, Kinshasa, and then eventually drains into the Atlantic Ocean.⁸⁷ While convenient, washing ore in the river can make its water radioactive and elevate risk of cancer while deteriorating the water quality by adding pollutants as the river flows westwards throughout the country.⁸⁸ Excess pollution from cobalt mining can have particularly harmful and radiating impacts on agriculture as 70% of the DRC’s population are engaged in and dependent on the agricultural sector.⁸⁹

In a 2022 study on the *Impacts of Trace Metals Pollution of Water, Food Crops, and Ambient Air on Population Health in Zambia and the DR Congo* by A. Muimba-Kankolongo et al., researchers surveyed plots in northern Zambia and in Katanga province, DRC. After examining collected food crop and water samples, results revealed dangerously high contamination levels of heavy metals and metalloids. Highest contamination in crops and water

⁸⁷ “Congo River,” Encyclopædia Britannica, Accessed March 2, 2023.



⁸⁸ Dorothee Baumann-Pauly, “Cobalt Mining in the Democratic Republic of the Congo: Addressing Root Causes of Human Rights Abuses.” NYU Stern Center for Business and Human Rights and Geneva Center for Business and Human Rights, February 8, 2023.

⁸⁹“Agriculture and Food Security: Democratic Republic of the Congo,” U.S. Agency for International Development, February 9, 2023.

Map 4: Congo River Flowing Through Cobalt Mining Districts



0 150 300 600 Miles

 Congo Rivers
 Cobalt Mining Permits

Caroline Mallory, March 4, 2023
Data Source:
Mining Permits: Global Forest Watch - Democratic Republic of the Congo Mining Permits
Rivers: World Bank - World Major Rivers
Projection: WGS 1984

was observed in the DRC, well above WHO guidelines for safe human consumption. Additionally, urine from people living in study areas was observed for metal concentrations. They found an abnormally high level of metalloids in all participants. The team also observed how soil erosion in surveyed communities impacted harvest yields as well as metalloid contamination of surface and groundwater. The study concludes that the mining and other extractive industries have resulted in contaminated water, plants, and landscape harming both the environment and the people living in it.⁹⁰

The significant demographic and environmental change in the southeastern Congo from increased global demand for cobalt has prompted research groups to begin evaluating the impacts of these changes. One such study is the *Sustainability of artisanal cobalt mining in the DR Congo* by Banza Lubaba Nkulu et al. They looked holistically at the impacts of cobalt mining on many aspects of the environment. Through their work, they discovered a strong indication that the degree of cobalt in surface dust is correlated with concentration of cobalt levels in people's blood and urine. This demonstrates that dust exposure is the most prominent method of human contamination as opposed to water and food ingestion. Researchers found that on average, the dust in cobalt mining regions vs a control (a nearby area with no past mining history) was 70-fold higher containing 1,100 $\mu\text{g}\text{g}^{-1}$ cobalt. The contamination of the air in exposed regions is indiscriminately impacting the entire population living in mining regions.⁹¹

The non-selective nature of cobalt exposure reveals a concerning future for the children growing up in the midst of cobalt mining. One problem to watch relates to the high concentration

⁹⁰ A. Muimba-Kankolongo *et al.*, "Impacts of Trace Metals Pollution of Water, Food Crops, and Ambient Air on Population Health in Zambia and the DR Congo." *Journal of Environmental and Public Health* 2022 (2022): 1–14.

⁹¹ Célestin Banza Lubaba Nkulu *et al.* "Sustainability of artisanal mining of cobalt in DR Congo." *Nat Sustain* vol. 1, (2018): 497.

of metalloids in children's urine in mining districts. The A. Muimba-Kankolongo et al. study found that in general, people in exposed regions have high levels of metalloids in their urine, but the Banza Lubaba Nkulu et al. study revealed that this disproportionately impacts children. According to the study, factors impacting this could include children's high gastrointestinal absorption and frequent hand-to-mouth contact while playing on the ground. As such, children had significantly high levels of metalloids in their urine as compared to adults and even higher levels of cobalt-U, cobalt-B, and manganese-U than creuseurs participating in the study. Additionally, when comparing children in the control versus in mining areas, children in the latter exhibited a 9.3-fold higher concentration of cobalt and around a 2-fold higher concentration in both uranium and manganese than non-exposed children. The future health impacts of this high concentration could be catastrophic given the large population living in exposed regions without proper access to medical care as the Banza Lubaba Nkulu et al. study found evidence of DNA damage in exposed children.⁹² According to the National Institutes of Health, such DNA damage can cause malformations, cancer, aging, and cell death.⁹³ The physical effect of environmental pollution on humans from mining is largely invisible right now as it manifests in the future generation. In contrast, the physical change of the environment from mining physically is ghastly.

In a 2022 study by Brown et al. on landscape analysis of Kolwezi from 2009-2021, the group observed how mining has altered the geography of the southern DRC. Brown et al. used "very high resolution (VHR) satellite imagery to map spatial distribution of land cover and land cover change, as well as analyse the spatial relationship between land cover classes and visually

⁹² Ibid., 495

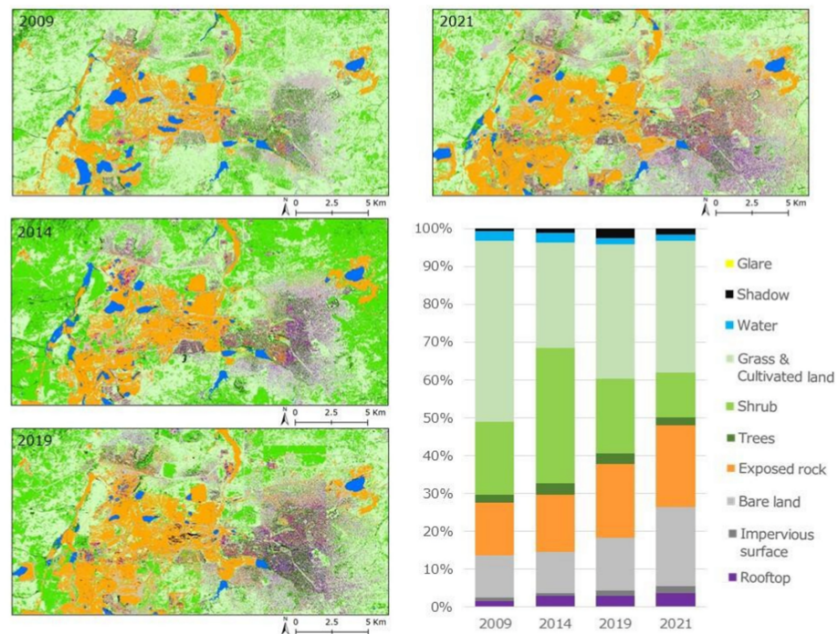
⁹³ Sharbel Weidner Maluf et al., "DNA Damage: Health and Longevity," *Oxidative Medicine and Cellular Longevity* 2018, (2018): 1–2.

identified mine features, from 2009 to 2021.” They used the classes in Figure 4 to analyze such observed changes.

Figure 4: VHR Classes

Class	Description
Rooftop	Includes: metal, clay, concrete building materials
Impervious surface	Includes: asphalt, low-albedo surfaces
Bare land	Includes: dirt track, construction sites, sediment deposits, bare soil
Exposed rock	Includes: mine pits, rock piles, tailings, smelt waste, natural rockslides
Trees	Includes: mature tree growth
Shrub	Includes: woody shrub species
Grass and Cultivated land	Includes: mixed grassland, cultivate land, low-cover herbaceous species
Water	Includes: rivers, lakes, ponds, water retention areas, streams
Shadow	Includes: shadowed areas
Glare	Includes: bright solar reflection

Figure 5: Landscape Change



Results from their analysis showed a shift in dominance of classes from 2009-2021. In 2009, the vegetation (trees, shrubland, grass/cultivated land) class and exposed rock class dominated the landscape. Analysis of the results showed that in 2021, the land cover reflected the rooftops class increased by 147.%, the impervious surface increased by 104.7%, the bare land class increased by 85.4%, the exposed rock class increased by 56.2%. The results showed trees decreasing by 4.5%, shrubs decreasing by 38.4%, grass and cultivated land decreasing by 27.1%, and water decreasing by 34.6%. They concluded that “the expansion of both the mining sector and urban development in Kolwezi between 2009 and 2021 had dramatically altered the landscape structure.”⁹⁴

The cyclical nature of climate change is revealed in the battle for land to be cleared for mining. Vast hectares of trees cleared in the DRC for EV batteries to reduce pollution is ironic. Between 2000-2020, formative years for the cobalt mining industry, the DRC experienced -3.6% change in tree cover. In 2021, it lost 1.25 Mha of natural forest which is equivalent to 822 Mt of carbon emissions according to Global Forest Watch.⁹⁵ This makes sense in the context of increased demand for cobalt and that “the majority of lands on which exploration permits have been granted are currently under forest cover.”⁹⁶ While not all as a result of clearing land for cobalt mining, it is hard to ignore the obvious landscape change with rapid development to support mining activities.

⁹⁴ Chloe Brown, Doreen S. Boyd, and Siddarth Kara, “Landscape Analysis of Cobalt Mining Activities from 2009 to 2021 Using Very High Resolution Satellite Data (Democratic Republic of the Congo),” *Sustainability* 14 (2022): 2.

⁹⁵ Global Forest Watch, “Democratic Republic of the Congo Deforestation Rates & Statistics,” Global Forest Watch, Accessed April 20, 2023.

⁹⁶ Andreas Wilkes, “China-Africa Forest Trade and Investment: An Overview with Analysis for Cameroon, Democratic Republic of Congo, Mozambique and Uganda,” *International Institute for Environment and Development*, (2016): 33.

Conclusion

As the primary actor in cobalt mining in the DRC, China is responsible for the human rights and environmental harms caused by artisanal mining. China is making a Hail Mary effort to relocate the pollution problem it helped cause to the DRC and clear up its own air while making the DRC's air toxic. The IPCC has acknowledged that the green energy revolution is necessary to mitigate irreversible damage caused by humans on our environment through the burning of fossil fuels. Cobalt is vital to solving this problem. That said, as it stands, the green energy revolution is not sustainable. Powered by cobalt extracted on the backs of children and the destruction of the environment in the southeast DRC, there needs to be mitigating efforts to make this a just transition.

While making the green energy revolution sustainable through cleaning up the cobalt industry is a daunting and expensive task, it is also an opportunity. The DRC's resources have not only been obtained for pennies on the dollar, but their people have suffered greatly. To make the global transition to green energy a just transition for the DRC, it is critical that mining interests linked to China work to introduce measures to clean up the industry. In order to begin repairing leftover symptoms of colonization, it is imperative that post-colonial nations like the DRC are included in this transition.

The DRC is often referred to as having the paradox of plenty.⁹⁷ While there is potential for economic growth and human prosperity resulting from cobalt mining in the DRC, the actors in charge of its fate have chosen to invest solely in their own interests rather than considering the interests of the Congolese. In reality, a sustainable cobalt mining industry in the DRC would

⁹⁷ Landry, "The Risks and Rewards of Resource-for-Infrastructure Deals: Lessons from the Congo's Sicomines Agreement," 165.

benefit China and other foreign actors in the long run by increasing production capacity and quality while reducing human and environmental cost. An investment into the cobalt mining industry to make it more sustainable could provide important benefits for the DRC, China, and the world. While cobalt mining in the DRC presents a great ethical problem, it also yields positive opportunities for development so that the DRC can capitalize on their own minerals and flip the narrative of the paradox of plenty.

The DRC government has introduced policy to formalize artisanal mining, though this plan is at a stalemate as the informal artisanal mining system benefits political elites.⁹⁸ The DRC has a responsibility to protect its citizens and this would help mitigate harms experienced in artisanal cobalt mining. A formalized system would consist of resilient institutions funded in part by profits from cobalt mines. Such institutions would mitigate harms associated with artisanal mining to decrease health and environmental risk by providing protective and appropriate equipment to artisanal miners. They would ensure sufficient working conditions and wages for everyone and allow parents to send their children to school instead of the mines. This would help contribute to a just transition.

Formalizing artisanal mining would not only make the practice safer therefore ensuring more human rights are protected, but it would also help the economy. One opportunity presented by artisanal mining is the ability for women to participate in the economy and bring home a living wage. The OECD finds that women's participation in the economy "speeds up development, helps overcome poverty, reduces inequalities and improves children's nutrition, health, and school attendance."⁹⁹ Artisanal mining attracts women who have grown up with little

⁹⁸ Victoria Beaulé, "Artisanal cobalt mining swallowing city in Democratic Republic of the Congo, satellite imagery shows," ABC News Network, February 8, 2023.

⁹⁹ "Investing in Women and Girls," Organisation for Economic Co-operation and Development, Accessed March 11, 2023.

opportunities. Here, training women of an appropriate age on safe extraction techniques while providing them with safety gear could yield more extraction of cobalt as well as gender equality, and potentially, more inclusive economic growth. Women would have greater ability for independence and participation in the economy helping the development of the DRC. This is not only significant for such women and their families, but for the greater economy overall. It is possible to flip the narrative of artisanal mining in the DRC, however many things need to happen before the final script is written.

Though China's foreign relations focus on economics before a moral agenda, one of the first arguments made in this paper is that China was motivated to turn to the DRC due to their own energy insecurity and vulnerability. As such, it is in China's strategic interest to introduce sustainable measures to cobalt mining. Due to violence and war over mining concessions and surrounding ethnic conflicts as well as the human impact of mining on the population of the DRC, China is actually still energy insecure as the supply chain of cobalt is perpetually unstable. Increased human rights violation and environmental degradation adds to the existing instability. As such, China should introduce measures to mitigate the harms on people and the environment caused by their cobalt mining operation.

In an ironic, but sad turn, the green energy revolution is anything but sustainable when considering the abuses in the supply chain of cobalt. Frankly, it is harmful. According to Deprese Muchena, a senior director at Human Rights Impact, "there can be no growth and sustainability of the mining industry without human rights."¹⁰⁰ Without considering the supply chain of cobalt,

¹⁰⁰ Amnesty International, "South Africa: Mining gathering must confront human rights violations." February 3, 2020.

it is incorrect to label EVs and other green energy technologies using cobalt with an opaque supply chain as sustainable.¹⁰¹

¹⁰¹ Lawson, “The DRC Mining Industry: Child Labor and Formalization of Small-Scale Mining.”

Works Cited

- Adams, Traci N., Yasmeeen M. Butt, Kiran Batra, and Craig S. Glazer. "Cobalt Related Interstitial Lung Disease." *Respiratory Medicine* 129 (2017): 91–97.
<https://doi.org/10.1016/j.rmed.2017.06.008>.
- Agence France-Presse. "DRC's Illegal Mining Dilemma." VOA Africa, November 2, 2022.
<https://www.voaafrica.com/a/drc-s-illegal-mining-dilemma/6816500.html#:~:text=Under%20DRC%20law%2C%20artisanal%20diggers,multi%2Dbillion%2Ddollar%20corporations.>
- Alden, Chris, and Daniel Large. "China's Exceptionalism and the Challenges of Delivering Difference in Africa." *Journal of Contemporary China* 20, no. 68 (2010): 21–38.
<https://doi.org/10.1080/10670564.2011.520844>.
- Amnesty International. "DRC: Alarming Research Shows Long Lasting Harm from Cobalt Mine Abuses." May 6, 2020.
<https://www.amnesty.org/en/latest/news/2020/05/drc-alarming-research-harm-from-cobalt-mine-abuses/>.
- Amnesty International. "South Africa: Mining gathering must confront human rights violations." February 3, 2020. <https://www.amnesty.org/en/latest/news/2020/02/south-africa-mining-gathering-must-confront-human-rights-violations/>
- Banza Lubaba Nkulu, Célestin, Lidia Casas, Vincent Haufroid, Thierry De Putter, Nelly D. Saenen, Tony Kayembe-Kitenge, Paul Musa Obadia, et al. "Sustainability of Artisanal Mining of Cobalt in DR Congo." *Nature Sustainability* 1, no. 9 (2018): 495–504.
<https://doi.org/10.1038/s41893-018-0139-4>.
- Baumann-Pauly, Dorothée. "Cobalt Mining in the Democratic Republic of the Congo: Addressing Root Causes of Human Rights Abuses." NYU Stern Center for Business and

Human Rights and Geneva Center for Business and Human Rights. February 8, 2023,
<https://gcbhr.org/insights/2023/02/cobalt-mining-in-the-democratic-republic-of-the-congo-addressing-root-causes-of-human-rights-abuses>.

Barwick, Panle Jia, Shanjun Li, Deyu Rao, and Nahim Bin Zahur. “The Impact of Air Pollution on Healthcare Spending in China.” VoxDev. VoxDev, April 18, 2019.
<https://voxdev.org/topic/health-education/impact-air-pollution-healthcare-spending-china#:~:text=Pollution%20is%20extremely%20costly.,increase%20in%20annual%20health%20spending>.

BBC. “Democratic Republic of Congo Profile - Timeline.” January 10, 2019.
<https://www.bbc.com/news/world-africa-13286306>.

BBC. “Top tech firms sued over DR Congo cobalt mining deaths.” December 16, 2019.
<https://www.bbc.com/news/world-africa-50812616>.

Beaule, Victoria. “Artisanal Cobalt Mining Swallowing City in Democratic Republic of the Congo, Satellite Imagery Shows.” ABC News Network, February 8, 2023.
<https://abcnews.go.com/International/cobalt-mining-transforms-city-democratic-republic-congo-satellite/story?id=96795773>.

Bloomberg Originals. “How Chinese Cash Flowed to Congo’s Former First Family.” YouTube video, 6:35-6:45. Posted by “Bloomberg Originals.” April 26, 2022.
<https://www.youtube.com/watch?v=m3BnmQNntnY&t=140s>.

BP. “Statistical Review of World Energy.” British Petroleum Co. 2021.
<https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html>.

Bradsher, Keith, and Michael Forsythe. “Why a Chinese Company Dominates Electric Car Batteries.” The New York Times. December 22, 2021.
<https://www.nytimes.com/2021/12/22/business/china-catl-electric-car-batteries.html>.

Brown, Chloe, Doreen S. Boyd, and Siddarth Kara, “Landscape Analysis of Cobalt Mining

Activities from 2009 to 2021 Using Very High Resolution Satellite Data (Democratic Republic of the Congo).” *Sustainability* 14 (2022): 1-20. <https://www.mdpi.com/2071-1050/14/15/9545#>.

Business Wire. “Research Report on China's Lithium-Ion Battery Export Industry, 2023-2032.”

Business Wire. January 19, 2023.

<https://www.businesswire.com/news/home/20230119005428/en/Research-Report-on-Chinas-Lithium-ion-Battery-Export-Industry-2023-2032---ResearchAndMarkets.com#:~:text=In%202021%2C%20China%20exported%203.427,%25%20year%2Don%2Dyear>.

Center for Preventative Action. “Instability in the Democratic Republic of Congo.” Council on

Foreign Relations. February 17, 2023. <https://www.cfr.org/global-conflict-tracker/conflict/violence-democratic-republic-congo>.

Chen, Stephen. “Chinese in Beijing Manage Cobalt Mines in Africa by Remote Control: Study.” *South China Morning Post*. December 7, 2022.

<https://www.scmp.com/news/china/science/article/3202385/chinese-using-mobile-phone-beijing-effectively-manage-cobalt-mines-africa-remote-control-study>.

Clowes, William, and Michael Kavanagh. “Document Leak Shows Kabila Family, Associates Looted DRC Funds.” *Al Jazeera*. November 19, 2021.

<https://www.aljazeera.com/economy/2021/11/19/document-leak-shows-kabila-family-associates-looted-drc-funds>.

Cobalt Institute. “Cobalt Market Report 2021.” May 17, 2022.

<https://www.cobaltinstitute.org/resource/state-of-the-cobalt-market-report-2021/>.

Coloma, Tristan. “Quand Le Fleuve Congo Illuminera L’Afrique - Le “Contrat Du Siècle.” *Le*

Monde diplomatique. February 1, 2011. <https://www.monde-diplomatique.fr/2011/02/COLOMA/20108>.

Congressional Research Service. “The United Nations Convention on the Rights of a Child.”

CRS Report R40484. Washington, D.C.: Congressional Research Service, 2015. <https://crsreports.congress.gov/product/pdf/R/R40484/25#:~:text=CRC%20entered%20in%20to%20force%20in,have%20not%20ratified%20the%20Convention>.

Edmonds, Eric V., and Caroline Theoharides. “Child Labor and Economic Development.”

Handbook of Labor, Human Resources and Population Economics. November 18, 2021.

- Nations, June 27, 2022. <https://www.un.org/africarenewal/magazine/june-2022/world-burning-we-need-renewables-revolution>.
- Gulley, Andrew L. "One Hundred Years of Cobalt Production in the Democratic Republic of the Congo." *Resources Policy* 79 (2022): 1-10.
<https://doi.org/10.1016/j.resourpol.2022.103007>.
- Human Rights Watch. "DR Congo: Ethnic Militias Attack Civilians in Katanga." August 11, 2015. <https://www.hrw.org/news/2015/08/11/dr-congo-ethnic-militias-attack-civilians-katanga>.
- International Labor Organization. "Green Jobs: What are Green Jobs?" ILO. 2021.
https://www.ilo.org/global/topics/green-jobs/WCMS_824102/lang-en/index.htm#:~:text=A%20Just%20Transition%20means%20greening,and%20leaving%20no%20one%20behind.
- IPCC. "The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change." Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press. 2021.
<https://www.ipcc.ch/report/ar6/wg1/>
- Jansson, Johanna. "The Sicomines Agreement Revisited: Prudent Chinese Banks and Risktaking Chinese Companies." *Review of African Political Economy* 40 (2013): 152-162.
<http://www.jstor.org/stable/42003311>.
- Kabemba, Claude. "China-Democratic Republic of Congo relations: from a beneficial to a developmental cooperation". *African Studies Quarterly* 16, no. 4 (2016): 73-88.
https://asq.africa.ufl.edu/wp-content/uploads/sites/168/v16a6.Kabemba.HD_.pdf.
- Kan, Haidong. "Environment and Health in China: Challenges and Opportunities," *Environmental Health Perspectives* 117, no.2 (2009): A530-A531.
<https://ehp.niehs.nih.gov/doi/10.1289/ehp.0901615>.
- Kim, Heejin. "China's CATL Extends Lead as World's Top Electric-Car Battery Maker." Bloomberg.com. Bloomberg, January 4, 2023.
<https://www.bloomberg.com/news/articles/2023-01-04/china-s-catl-extends-lead-as-world-s-top-ev-battery-maker#xj4y7vzkq>.
- Kinda, Harouna and Noel Thiombiano. "The effects of extractive industries rent on deforestation in developing countries." *Resources Policy* 73 (2021): 1-14.

<https://doi.org/10.1016/j.resourpol.2021.102203>.

Kobayashi, Shigeo, Jia Baobo, and Junya Sano. “The ‘Three Reforms’ in China: Progress and Outlook.” Sakura Institute of Research, Inc., September 1999.

<https://www.jri.co.jp/english/periodical/rim/1999/RIME199904threereforms/>.

Kowene, Gaius. “Has Felix Tshisekedi Tackled DR Congo's Six Biggest Problems?” BBC News.

January 24, 2020. <https://www.bbc.com/news/world-africa-51220974>.

Landry, David. “The Risks and Rewards of Resource-for-Infrastructure Deals: Lessons from the Congo's Sicomines Agreement.” *Resources Policy* 58 (2018): 165–74.

<https://doi.org/10.1016/j.resourpol.2018.04.014>.

Lawson, Michele Fabiola. “The DRC Mining Industry: Child Labor and Formalization of Small-

Scale Mining.” Wilson Center, September 1, 2021. <https://www.wilsoncenter.org/blog-post/drc-mining-industry-child-labor-and-formalization-small-scale-mining>.

Macrotrends. “China Population Growth Rate 1950-2021.” 2021.

<https://www.macrotrends.net/countries/CHN/china/population-growth-rate>.

MacroTrends. “Democratic Republic of Congo GDP per Capita 1960-2023.” MacroTrends.

2023. <https://www.macrotrends.net/countries/COD/democratic-republic-of-congo/gdp-per-capita#:~:text=Democratic%20Republic%20of%20Congo%20gdp%20per%20capita%20for%202021%20was,a%205.43%25%20increase%20from%202018>.

Maiza-Larrarte, Andoni and Gloria Claudio-Quiroga, “The impact of Sicomines on development in the Democratic Republic of Congo.” *International Affairs* 9. no. 2 (2019): 423–446.

<https://doi.org/10.1093/ia/iiz001>.

Maluf, Sharbel Weidner, Wilner Martínez-López, and Juliana da Silva. “DNA Damage: Health and Longevity.” *Oxidative Medicine and Cellular Longevity* 2018, (2018): 1–2.

<https://doi.org/10.1155/2018/9701647>.

Mihalyi, David, Aisha Adam, and Jyhjong Hwang. “Resource-Backed Loans: Pitfalls and

Potential: Executive Summary.” Natural Resource Governance Institute. February 2020.

<https://resourcegovernance.org/sites/default/files/documents/resource-backed-loans-executive-summary.pdf>

Mining Data Online. “Major Mines & Projects: Tenke Fungurume Mine.” MDO Data Online

Inc. Accessed March 28, 2023. <https://miningdataonline.com/property/302/Tenke-Fungurume-Mine.aspx>.

Mount Sinai Health System. “Cobalt Poisoning.” Icahn School of Medicine at Mount Sinai. Accessed March 28, 2023. <https://www.mountsinai.org/health-library/poison/cobalt-poisoning>.

Muimba-Kankolongu, A., C. Banza Lubaba Nkulu, J. Mwitwa, F. M. Kampemba, and M. Mulele

Nabuyanda. “Impacts of Trace Metals Pollution of Water, Food Crops, and Ambient Air on Population Health in Zambia and the DR Congo.” *Journal of Environmental and Public Health* 2022 (2022): 1–14. <https://doi.org/10.1155/2022/4515115>.

Niarchos, Nicolas. “The Dark Side of Congo's Cobalt Rush.” *The New Yorker*, May 24, 2021.

<https://www.newyorker.com/magazine/2021/05/31/the-dark-side-of-congos-cobalt-rush>

Natural Resource Governance Institute. “The Resource Curse: Understanding the Challenges and Opportunities for Resource-Dependent Countries.” 2015.

https://resourcegovernance.org/sites/default/files/nrgi_Resource-Curse.pdf.

NBC News. “Review of Congo War Halves Death Toll.” January 20, 2010.

<https://www.nbcnews.com/id/wbna34958903>.

Office of the United Nations High Commissioner for Human Rights. “Convention on the Rights of the Child.” Accessed April 21, 2023. <https://www.ohchr.org/en/instruments-mechanisms/instruments/convention-rights-child>.

Organisation for Economic Co-operation and Development. “Investing in Women and Girls.”

Accessed March 11, 2023. <https://www.oecd.org/dac/gender-development/investinginwomenandgirls.htm#:~:text=Women's%20economic%20participation%20and%20their,%2C%20health%2C%20and%20school%20attendance>.

Piontkovska, Maria and Doriane Nguenang. “US Court Dismissed Cobalt Mining Forced Labor

Lawsuit Against Tech Companies.” Global Supply Chain Compliance. Baker McKenzie.
November 18, 2021.

<https://supplychaincompliance.bakermckenzie.com/2021/11/18/us-court-dismissed-cobalt-mining-forced-labor-lawsuit-against-tech-companies/>

Posner, Michael. “To Meet Global Cobalt Demand, Companies Must Reform Mining Practices in the Congo.” *Forbes*, February 10, 2023.

<https://www.forbes.com/sites/michaelposner/2023/02/09/as-demand-soars-for-cobalt-used-in-electric-car-batteries-heres-what-companies-need-to-do-in-the-democratic-republic-of-congo/>.

Reuters. “Microsoft Calls for 'Coalition' to Improve Congo's Informal Cobalt Mines.” February 8, 2023. <https://www.reuters.com/markets/commodities/microsoft-calls-coalition-improve-congos-informal-cobalt-mines-2023-02-08/#:~:text=Congo%20accounts%20for%20three%2Dquarters,that%20fluctuates%20depending%20on%20price.>

Ross, Aaron, and Helen Reid. “Congo's \$6 Bln China Mining Deal 'Unconscionable', Says Draft Report.” Reuters, October 8, 2021. <https://www.reuters.com/business/congos-6-bln-china-mining-deal-unconscionable-says-draft-report-2021-10-08/>.

Shirambere, Philippe Tunamsifu. "The Democratic Republic of the Congo-China's Deals on Construction of Roads in Exchange of Mines", *Afrika Focus* 33, no. 2 (2020): 79-94, <https://doi.org/10.1163/2031356X-03302008>.

Trading Economics. “Congo GDP.” Trading Economics. 2022,
<https://tradingeconomics.com/congo/gdp>.

Trefon, Theodore. *Congo's Environmental Paradox*. London: Routledge, 2016.

UNDP “Human Development Index.” Human Development Reports- United Nations Development Program. January 23, 2023. <https://hdr.undp.org/data-center/human-development-index>.

United States Environmental Protection Agency. "What is Green Power?" Accessed April 17, 2023. <https://www.epa.gov/green-power-markets/what-green-power>.

U.S. Agency for International Development. “Agriculture and Food Security: Democratic

Republic of the Congo.” February 9, 2023. <https://www.usaid.gov/democratic-republic-congo/agriculture-and-food-security>.

U.S. Geological Survey. “Cobalt Statistics and Information.” Accessed March 28, 2023.

<https://www.usgs.gov/centers/national-minerals-information-center/cobalt-statistics-and-information>.

Wilkes, Andreas. “China-Africa Forest Trade and Investment: An Overview with Analysis for Cameroon, Democratic Republic of Congo, Mozambique and Uganda.” *International Institute for Environment and Development* (2016): 1-68.
<http://www.jstor.org/stable/resrep02688>.

Women’s International League for Peace & Freedom. “Life at the bottom of the chain: women in artisanal mines in DRC.” Women’s International League for Peace & Freedom, 2018.
https://wilpf.org/wp-content/uploads/2016/10/WomenInArtisanalMinesInDRC_web.pdf

World Bank. “GDP (current US\$) - China.” Accessed March 4, 2023.

<https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=CN>.

World Bank. “Physicians (per 1,000 people).” Accessed April 17, 2023.

<https://data.worldbank.org/indicator/SH.MED.PHYS.ZS?locations=CD>.

World Bank. “The World Bank in DRC.” October 11, 2022.

<https://www.worldbank.org/en/country/drc/overview>.

World Economic Forum. “The 13 Fastest-Growing Economies in the World.” June 22, 2015.

<https://www.weforum.org/agenda/2015/06/the-13-fastest-growing-economies-in-the-world/>.