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GREEN ENERGY TRANSITIONS: CONGO'S 'MODERN-DAY SLAVERY' IN RAW MATERIALS DEMANDS

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Abstract
The Democratic Republic of the Congo (DRC), a country rich in cobalt and coltan—two elements necessary for renewable technologies—has come under greater investigation as a result of the worldwide shift to green energy, yet its miners are exploited. This qualitative study, which was based on the resource curse and human security theories, used document analysis of previous studies, policy reports, and current events to examine the conflicting reality of resource exploitation in the Democratic Republic of the Congo and the aspirations for green energy. The results show that although programs encouraging ethical production and responsible sourcing have promise, structural problems like child labor, forced labor, and dangerous working conditions still exist and threaten the fundamental safety and dignity of local people. In order to guarantee that the DRC's resource richness promotes equitable development rather than exploitation, this study highlights the necessity of international accountability systems and moral behavior that places a higher priority on human security and dignity.

Keywords: Democratic Republic of the Congo, human, raw materials

Introduction
The green revolution, with its promise of clean energy and a sustainable future, shines a spotlight on the DRC. This resource-rich land holds the key to many of the minerals vital for batteries and renewable technologies – lithium, cobalt, and coltan (van Staden, 2022). Yet, beneath this verdant hope lies a chilling reality: the persistent nightmare of modern slavery woven into the fabric of raw material extraction. The global scramble for clean energy solutions has cast a spotlight on the DRC, a land whose bountiful reserves of critical minerals – lithium, cobalt, coltan – hold the key to powering our future. However, the persistent stain of modern slavery is deeply embedded in the mining industry (reliefweb, 2023). For far too long, the extraction of these vital resources has been shrouded in a veil of opacity, fueling a human rights crisis in the heart of the DRC (ICF Macro, 2023). Child labor, forced work, and brutal working conditions remain pervasive, casting a long shadow over the green aspirations driving the global rush toward renewable technologies (ILO, 2019).

DRC's positions on high demands of raw materials

The existence of DRC is crucial to the global supply of raw minerals vital for the green energy transition, including cobalt, copper, and tantalum. The Democratic Republic of the Congo, as the foremost supplier of cobalt, contributes over 70% of the global supply, making it essential for the manufacturing of lithium-ion batteries utilized in electric vehicles, renewable energy storage, and electronic devices (Pelon et al., 2021). Its exceptional mineral deposits render it essential to global supply networks, especially as demand escalates owing to the transition to renewable energy. Nonetheless, despite its abundant resources, the DRC encounters considerable obstacles in converting these assets into sustained economic advancement. The mining sector, accounting for around 20% of the nation's GDP, is marked by minimal local value addition, as the majority of raw materials are exported unprocessed, so diminishing the economic advantages for the country (EITI, 2022).

The nation's mining industry is afflicted by labor exploitation, characterized by hazardous working conditions, child labor, and inadequate remuneration, particularly in artisanal mining, which engages millions of workers yet functions predominantly outside formal regulation (Bureau of International Labor Affairs, 2018). These problems are intensified by inadequate governance, corruption, and ineffective enforcement of labor and environmental regulations. Moreover, the DRC's reliance on foreign corporations, especially Chinese enterprises that monopolize its mining sector, prompts apprehensions over neo-colonial exploitation and insufficient local governance over resources (Karlsson, 2019). Despite governmental attempts to regulate the sector, including the 2018 revision of the Mining Act to augment taxes and royalties, enforcement remains erratic (Justice & Paix, 2019).

The increasing worldwide demand for essential minerals offers prospects and obstacles for the DRC. It has the potential for economic growth, job creation, and increased income if the industry is managed effectively (World Bank, 2016). On the other hand, meeting this demand while addressing issues of governance, the environment, and society poses a significant challenge. Though development has been slow, initiatives to build local processing facilities and collaborate with international organizations to promote ethical sourcing are encouraging steps. Due to its strategic importance in the global green energy transition, the Democratic Republic of the Congo is a target of international competition, particularly as China's mining industry's domination grows. Significant reforms, better governance, and a commitment to sustainable practices are necessary to address these issues and ensure that the country's abundant natural resources are used fairly.

Green transitions aspects

The DRC is at a turning point in the history of green transitions worldwide. It is positioned as a potential powerhouse in the transition to renewable energy due to its abundant supply of minerals like cobalt, lithium, and coltan, which are essential for solar panels, electric cars, and wind turbines. However, this wealth of resources is combined with a history of violence, environmental problems, and exploitative practices, creating a challenging jigsaw that affects local people, international climate initiatives, and ethical sourcing in the green era. The DRC has a lot of prospects as a result of the green transformation (reliefweb, 2023). The

nation's abundant mineral resources are essential to meeting the unquenchable demand for sustainable energy technologies. This leads to possible improvements in infrastructure, employment, and the economy. Sustainable and ethical resource extraction might spur development, improve communities, and even help the DRC make the switch to renewable energy. However, the path to realizing this potential is fraught with challenges. Environmental concerns loom large. Mining activities often leave behind a trail of deforestation, water pollution, and biodiversity loss. Striking a balance between resource extraction and ecological protection is paramount. The human cost also demands attention (Diene et al., 2022). Child labor, unsafe working conditions, and exploitation have plagued the mining sector, casting a shadow over any economic gains. To truly tap into the potential of the green transition, the DRC must prioritize fair and ethical labor practices (Human Rights Watch, 2022).

Governance challenges further complicate the picture. Corruption, lack of transparency, and weak institutions can hinder sustainable development and prevent equitable distribution of benefits from resource extraction. To make sure that everyone benefits from the resource boom, not just a few chosen elites, it is imperative to strengthen governance and increase transparency. It takes a multifaceted strategy to navigate this complicated terrain. International cooperation is essential. Governments and businesses worldwide must commit to ethical sourcing methods that put human rights, environmental preservation, and fair labor standards first. Strong due diligence, traceability procedures, and assistance for artisanal mining communities are required for this. Important actions in the DRC include bolstering regulatory frameworks, enhancing transparency, and funding infrastructure for renewable energy and environmental rehabilitation. A truly egalitarian and sustainable future depends on developing skills, diversifying the economy beyond minerals, and enabling local communities to take part in decision-making.

The DRC has a rare chance to move past its turbulent past and onto a path of sustainable development thanks to the green transition. However, this is only possible if the difficulties are confronted head-on and the advantages are distributed fairly (World Bank, 2023). It takes dedication, teamwork, and a resolute focus on sustainability, equity, and environmental well-being to put the puzzle pieces together into a prosperous future. The DRC can turn its abundance of natural resources into a driving force for a green and just future—not just for itself, but for the entire planet—by making investments in ethical business practices, giving environmental preservation top priority, and empowering local communities. It's a complex story, filled with challenges and opportunities, and its outcome will depend on the choices we make collectively.

In the DRC, small-scale mining encompasses individuals of various ages, including children, who are compelled to toil in challenging environments. Among the 255,000 Congolese engaged in cobalt mining, a staggering 40,000 are children, with some as young as six years old (Lawson, 2021). The majority of this labor falls within the informal small-scale mining sector, where workers earn meager wages, often less than $2 per day, relying predominantly on their own tools, mainly their hands. A lawsuit has implicated several major tech corporations, including Apple, Alphabet (the parent company of Google), Dell, Microsoft, and Tesla, in cases involving fatalities and severe injuries among child laborers in cobalt mines in the

DRC (Lawson, 2021). Holding these big-tech companies responsible is a commendable initiative, but it should be complemented by raising public awareness about the exploitation of child labor and the appalling working conditions in small-scale mining operations. Surging global demand for cobalt threatens a delicate balance between green energy adoption and environmental consequences in DRC (Kelly, 2019). While cobalt is a crucial component in batteries powering the transition to renewable energy, its rapid extraction in the DRC poses serious risks to the country's environment and biodiversity. Cutting down trees and building roads for mining operations fragment sensitive ecosystems and endanger plant and animal species (Murray, 2022). Furthermore, cobalt mining itself is a significant contributor to global warming. The process generates staggering levels of carbon dioxide and nitrogen dioxide emissions, alongside a massive appetite for electricity. This contributes disproportionately to Africa's share of global carbon dioxide emissions, despite the continent accounting for only a small fraction of global energy consumption.

According to the latest global estimates, there are a total of 152 million children in child labor and 25 million children and adults in forced labor in the world today (International Organization for Migration (IOM), 2017). While it is possible to estimate with growing precision the total number of people in child labor and forced labor, determining how many of these people are in production and consumption linked to global supply chains remains a significant challenge (ILO, 2019). The goods and services purchased by consumers are composed of inputs from many countries around the world and are processed, assembled, packaged, transported, and consumed across borders and markets. Mapping these intricate supply chains, or, to use a more descriptive metaphor, supply “webs”, is complex (Reuters, 2024). Identifying where and to what extent child labor, forced labor, and human trafficking occur along these supply chains is even more so. Tracing the origins of a final product or even its components requires capturing statistics not only in the market where the product is “consumed”, but also all along its supply chain, a task that is beyond the scope of traditional survey and national accounting methods. For example, identifying child labor at each segment of a global supply chain would require very detailed information on the sectoral composition of child labor and the interdependencies between industries within an economy and across countries.

The DRC has a long and troubled history of forced labor and inhumane treatment of workers, particularly in the mining sector (Kennedy, 2013). This phenomenon has drawn international scrutiny and condemnation, raising concerns about human rights abuses and ethical sourcing of minerals like cobalt, which is essential for many modern technologies (Amnesty International, 2016b). The DRC is under intense scrutiny as a result of the worldwide rush for sustainable energy options. The DRC has the potential to drive the green revolution since it is rich in minerals like cobalt and lithium which are essential for green technologies (Smith & Merkley, 2023). Yet, its landscape is shrouded in a troubling reality: allegations of inhumane mining practices, including child and forced labor, cast a long shadow over the sustainability and ethics of this transition (Pienaar, 2020).

On the one hand, worldwide collaboration towards renewable energy sources is compelled by the urgency of climate change. Clean energy is a key component of multilateral agreements like the Paris Agreement, which bind countries to

aggressive carbon reduction objectives (United Nations Framework Convention on Climate Change, 2025). However, environmental degradation and human rights cannot be ignored in this effort. Ethical mineral sourcing issues and ensuring developing nations have a fair transition become important factors. At the center of this intricate equation is the DRC (United Nations Environment Programme, 2023). It is positioned as a major player in the green transition because of its mineral endowment, which is essential for solar panels, batteries, and other green technology. However, tales of terrible working conditions, including child labor and hazardous working circumstances, in Congolese mines raise alarming concerns about the human cost of our aspirations for clean energy.

In this hazy ethical environment, international law provides a lighthouse. The United Nations Guiding Principles on Business and Human Rights encourage businesses to stop human rights violations across their supply chains, while the International Labour Organization (ILO) works relentlessly to combat child labor and forced labor. However, in the context of the DRC, these frameworks encounter significant obstacles. Proper implementation and enforcement are hampered by political instability, corruption, and weak governance.

Strategic diplomacy and focused development initiatives are needed to close the gap between the harsh realities of the DRC and the idealistic principles of international law. By providing a framework for moral sourcing methods, the European Union's "Responsible Sourcing of Minerals" law seeks to guarantee sustainability and traceability in mineral imports. Programs for international development assistance, meantime, can be extremely important in bolstering governance, enhancing mining methods, and sustaining lives in mining communities. Investigating substitute technologies that are less dependent on vital minerals is necessary to lessen the load on the DRC and other resource-rich nations. A more varied and just green future depends on battery technology research and the investigation of substitute materials like sodium. In the end, elevating the voices of local communities and civil society organizations in the DRC is essential to guaranteeing a fair and sustainable green transition. Navigating this intricate global issue requires giving people the tools they need to fight for their rights, better working conditions, and environmental preservation.

Method

This qualitative study explored the complex connections between human rights abuses, green energy transitions, and the DRC's raw material mining sector. The DRC, which is abundant in resources like cobalt, lithium, and copper, is crucial to the global transition to renewable energy. These minerals are necessary for the production of solar panels, batteries, and other technologies that are crucial for reducing carbon emissions. Child labor, forced labor, and dangerous working conditions are among the structural issues plaguing the DRC's mining sector, which are frequently characterized as "modern-day slavery." Demand for these essential minerals has surged as the globe shifts to cleaner energy sources, creating a moral dilemma where severe violations of human rights clash with the objectives of environmental justice and sustainability.

The study mapped the relationships between significant themes, authors, and institutions in a range of publications that are indexed in Scopus using Vosviewer. The method employed in this analysis was centered on qualitative research and text

mining techniques to understand how the green energy discourse links to human rights concerns, particularly in the context of the DRC. The study emphasized the prevalent narratives in the body of existing literature and identified potential gaps in the discussion of ethical mining practices and sustainable sourcing by displaying clusters of research and finding the most frequently used keywords associated with the topic. These observations implied that although the DRC's contribution to the green energy revolution is becoming more widely recognized, the actual implementation of these developments, where exploitation is still pervasive, contrasts sharply.

The difference between the discussion of the green energy transition and the human cost of getting the materials required for this change is one of the mapping exercise's main conclusions. Although most studies focus on environmental advantages and technological developments, the study finds that the DRC's mining industry's human rights abuses are mostly ignored. A more comprehensive approach to sustainable development is required in light of this vacuum in the literature, one that places equal emphasis on the welfare of vulnerable groups engaged in the extraction processes as well as environmental sustainability. In order to ensure that the transition to a sustainable future does not come at the expense of sustaining modern-day slavery in the Democratic Republic of the Congo, it is imperative that going forward, a more inclusive discourse be fostered that highlights the human rights implications of raw material extraction as well as the green energy transition. Therefore, this study tries to answer the question “How are forced labor and human rights abuses in the mining industry of the Democratic Republic of the Congo exacerbated by the worldwide demand for raw materials for green energy transitions?”

Findings and Discussion

This qualitative study reference relies heavily on prior research that is both valid and the closest to linked articles for the comparison elements. There were generally 31 articles on Scopus that have the closest discussion, but mostly this study focused on 6 articles based on the keyword search down below;

TITLE-ABS-KEY (drc AND human AND mining) AND (LIMIT-TO (SUBJAREA , "SOCI"))

This study examines the social, economic, and political aspects of mining in the Democratic Republic of the Congo by concentrating on social sciences and utilizing the keywords DRC, human, and mining in Scopus. Instead of focusing only on the technical aspects of mining, this approach helps discover labor conditions, human rights issues, governance challenges, and socio-economic repercussions on local communities. A comprehensive grasp of the wider ramifications of resource extraction can be achieved by focusing the research on the social sciences, which allows it to examine how mining impacts societal structures, migration trends, inequality, and policy responses. By connecting sociology, political science, and development studies, this viewpoint also strengthens multidisciplinary views and adds to important conversations on ethical and sustainable mining methods.

The following chart provides additional information about the research development of the issue over time.

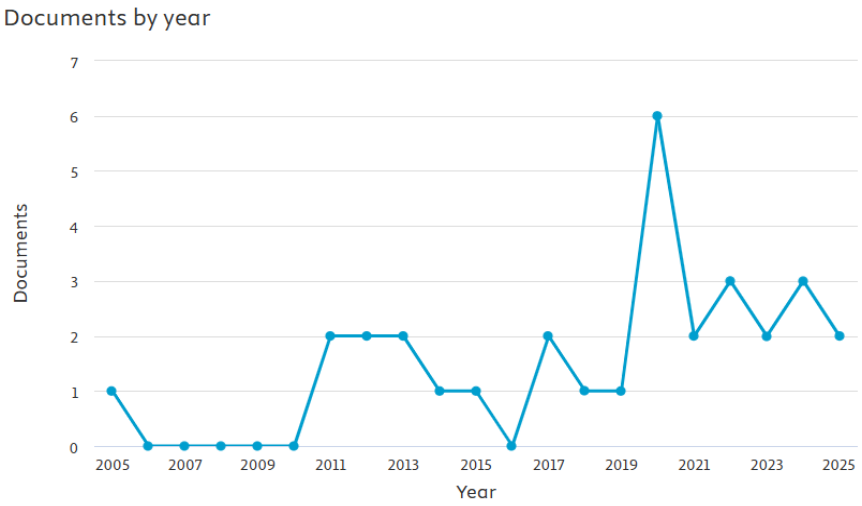

Figure 1. Scopus Document Analysis Each Year

Based on Scopus data analysis, it can be seen that research on DRC, humanity, and mining issues have fluctuating activities from 2005 to 2025. The focus here can be examined by how much the articles talk about this topic from 2017 until this year. Between 2019 and 2021, there are a total of 6 documents examining various aspects related to humanitarian and mining issues. The chart shows that from 2017 to 2019 there were massive activities on scientific research and then went downhill, yet fluctuating again in 2021 until 2025. Furthermore, we can visualize most of the issues in this research.

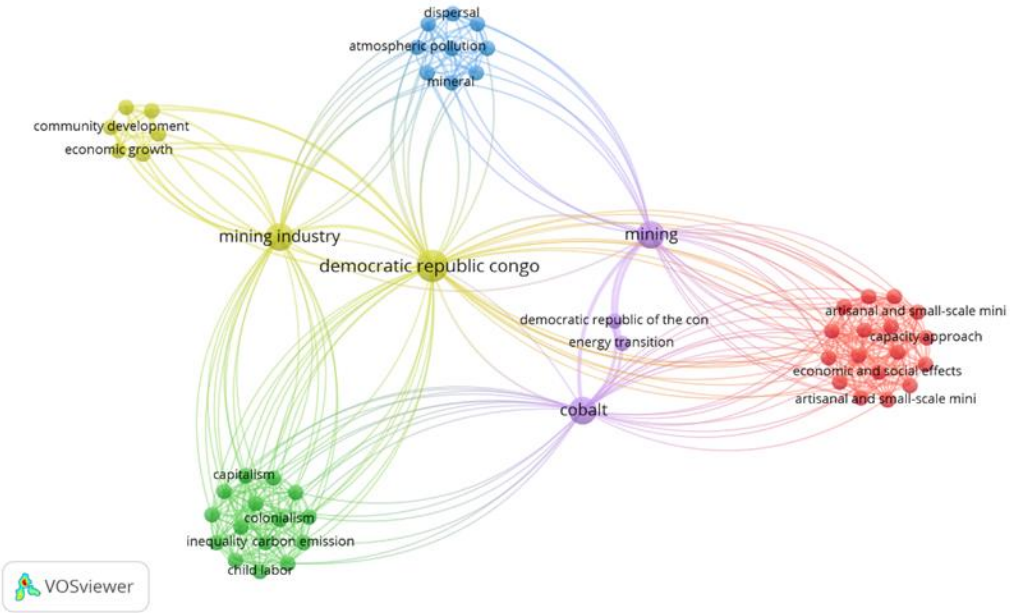

Figure 2. VosViewer Map on Analysis

From the VosViewer cluster analysis above, we can see based on all the 31 Scopus documents which quoted some specific terms like *Capitalism, Colonialism, Child Labor, Economic and Social Effects*, etc. However, since this research highly focused on some specific terms it will be later discussed in the discussion section.

Several studies have almost discussed the same aspects as this research like**; Coltan Mining and Conflict in the Eastern Democratic Republic of Congo DRC** by Taka Miho (2017), **African Artisanal Mining from the Inside Out: Access, Norms and Power in Congo's Gold Sector** by Sara Geenen (2015) and **Understanding the Sourcing and Manufacturing of Technology** by Shistaa Pareek (2024)**.** The three articles all center on the extractive industries and how they affect global supply chains, especially when it comes to the extraction of gold, coltan, and other minerals necessary for manufacturing technology. They highlight the ways that uncontrolled mining worsens economic inequality and fuels conflict, calling attention to ethical concerns such as labor exploitation, dangerous working conditions, corruption, and environmental harm. All three also call for better governance, corporate responsibility, and regulatory reforms to promote sustainable practices and ethical sourcing while ensuring that resource extraction does not contribute to violations of human rights or the environment. The three articles all focus on the extractive industries and how they affect global supply chains, particularly mining minerals like gold, coltan, and others that are essential for technology development.

Other 3 topics have the same frequency of the topic, like **Investigating the Potential of Radar Interferometry for Monitoring Rural Artisanal Cobalt Mines in the Democratic Republic of the Congo** by Chloe Brown et al. (2020), **Constraints, Opportunities, and Hope: Artisanal Gold Mining and Trade in South Kivu (DRC)** by Sara Geenen (2011), and **How to Reduce Conflicts Between Mining Companies and Artisanal Miners in the Province of Lualaba** by Emmanuel Umpula Nkumba (2020). The other three papers address significant issues such as poor working conditions, environmental harm, and conflicts with large mining firms while demonstrating the economic significance of artisanal and small-scale mining (ASM) in the Democratic Republic of the Congo. They draw attention to the ways that unclear legal systems and bad governance, such as land disputes, a lack of environmental control, or the exclusion of artisanal miners from formal markets, can cause conflict. Despite these issues, the articles advocate for sustainable and inclusive solutions, including regulations that encourage cooperation between local governments, mining companies, and communities, the official registration of artisanal miners, and the use of technology for better monitoring. Instead of making ASM illegal, they propose regulatory improvements that protect workers' rights, improve safety, and promote environmentally friendly mining practices.

Discussion

Forced labor workers

Based on the most recent global assessments, there are a total of 152 million children engaged in child labor and 25 million individuals, including both children and adults, subjected to forced labor worldwide. Although there is an increasing precision in estimating the overall figures for child and forced labor, accurately determining the extent to which these individuals are involved in the production

and consumption tied to global supply chains poses a substantial challenge (ILO, 2019). The products and services bought by consumers are a result of inputs from numerous countries worldwide, undergoing processes such as assembly, packaging, transportation, and consumption across international borders and markets. Mapping these intricate supply chains, often referred to as supply "webs," is a complex task. The even more challenging aspect is identifying the occurrences of child labor, forced labor, and human trafficking along these supply chains. Tracing the origins of a final product or its components necessitates collecting data not only in the market where the product is ultimately consumed but also throughout its entire supply chain. This undertaking exceeds the capabilities of traditional survey methods and national accounting practices. To illustrate, pinpointing child labor at each stage of a global supply chain demands highly detailed information about the sectoral distribution of child labor and the interconnections between industries within an economy and across different countries.

Siddharth Kara, a fellow at Harvard's T.H. Chan School of Public Health and the Kennedy School, has delved into research on modern-day slavery, human trafficking, and child labor for twenty years. According to Kara, rechargeable batteries in popular devices like smartphones, computers, and electric vehicles often rely on cobalt mined under conditions resembling slavery in the Democratic Republic of the Congo (Gross, 2023). Despite the DRC possessing more cobalt reserves than the rest of the world combined, Kara argues that there is no such thing as a "clean" cobalt supply chain from the country. In his latest book, "Cobalt Red," Kara highlights that a significant portion of the DRC's cobalt is extracted by "artisanal" miners, freelancers engaging in perilous work for minimal pay (Gross, 2023). These miners employ primitive tools like pickaxes, shovels, and rebar to extract cobalt in harsh conditions, contributing to the degradation of the environment in the DRC. Kara emphasizes that the mining industry has led to deforestation, air pollution with dust and grit, and water contamination with toxic byproducts. Additionally, cobalt itself is hazardous, and many impoverished Congolese, including young mothers with babies, are exposed to its toxicity daily (Vives, 2023).

Child labor abuse

Child and forced labor stain the cobalt supply chain, a crucial mineral for lithium-ion batteries and other key components in modern technologies, including electric vehicles. A substantial 80% of the world's cobalt lies beneath the surface in the Democratic Republic of the Congo (DRC), where Chinese companies dominate the mining and refining processes (Amnesty International, 2016a). Chinese firms own 80% of the DRC's cobalt output, refining it in China before selling it to battery manufacturers globally (Congressional-Executive Commission on China, 2023). Cobalt mining is associated with severe human rights violations, exposing workers to hazardous conditions and relying on child and forced labor in the DRC. The U.S. Department of Labor estimates that at least 25,000 children work in cobalt mines in the country.

This hearing aims to further the efforts of the CECC (Congressional-Executive Commission on China) to unveil forced labor and abuses in supply chains linked to China, ensuring that goods produced with such labor are not allowed into U.S. markets. Witnesses will testify about the negative impact of Chinese

companies in cobalt supply chains, the extent of child and forced labor in DRC-originating supply chains, the People's Republic of China's (PRC) contribution to environmental degradation in the region, and recommendations for U.S. action. In the DRC, the growth of large-scale cobalt and copper mining has led to severe violations of human rights, such as beatings, sexual assault, and arson, as well as the forced relocation of entire towns. Communities have been uprooted as a result of multinational corporations' haste to expand mining activities, according to a report by Amnesty International and the DRC-based group Initiative pour la Bonne Gouvernance et les Droits Humains (IBGDH).

Agnès Callamard, the secretary general of Amnesty International, highlights the necessity of stopping forced evictions during mining expansions. She acknowledges the significance of rechargeable batteries in the energy transition but calls for a fair strategy that does not jeopardize human rights. (Amnesty International, 2023b). The global demand for clean energy technologies has increased the need for metals like copper and cobalt, essential for lithium-ion batteries used in electric cars and mobile phones. The DRC, holding the world's largest cobalt reserves and seventh-largest copper reserves, faces rising pressure due to the growing demand for cobalt, expected to reach 222,000 tonnes by 2025 (Amnesty International, 2023a). IBGDH President Donat Kambola highlights the coercion and lack of accountability faced by communities affected by mining expansions.

Child labor and forced labor, especially in the Democratic Republic of the Congo, are major human rights issues in the cobalt supply chain. Despite the demand for clean energy, cobalt mining is still associated with hazardous working conditions, child labor, and forced displacement. Reports highlight the negative impacts on local communities, including evictions and abuse, while Chinese businesses dominate the sector, making accountability difficult. Congressional-Executive Commission on China calls for stronger regulations to prevent goods made with forced labor from entering international markets. Green technology needs cobalt, but ethical and ecological supply chains must come first to protect human dignity.

Conclusion

In conclusion, the qualitative analysis of Scopus research articles and Vosviewer mapping show the complex relationship between human rights abuses in the DRC and the shift to green energy. As the world's need for raw materials like cobalt to power renewable energy technologies increases, the Democratic Republic of the Congo remains at the center of a "modern-day slavery" crisis, with child and forced labor rampant in its mining industry. Even while green energy is crucial for reducing carbon emissions, the ethical quandaries brought up by the sourcing of raw materials from countries like the Democratic Republic of the Congo demand immediate attention, as is evident from the mapping of research trends and the analysis of key topics. To make sure that the transition to sustainable energy does not prolong exploitation and human rights abuses, the report highlights the necessity of international cooperation and more robust regulatory frameworks.

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