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Regulatory Framework on Environmental Harm in Informal Artisan Mining in the Democratic Republic of the Sudan and Congo

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Abstract

This research examines the regulatory mechanisms governing environmental damage in the ASM sectors of the Democratic Republic of the Congo (DRC) and Sudan. Although the sector is a key component of these communities' livelihoods, it also drives environmental destruction through unregulated mercury use and deforestation. The problem statement centers on the respective countries' inability to enforce national mining codes in line with their environmental laws. This research identifies gaps in both countries' national legal frameworks and proposes a harmonized approach that balances mineral extraction with environmental conservation. Through a systematic doctrinal analysis of primary and secondary legal sources, the study finds that the industry's major challenges include weak government regulation, corruption, and large-scale bias. The study concludes that these existing legal mechanisms are reactive rather than proactive.

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1. Introduction

ASM represents an essential source of livelihood for millions in the Democratic Republic of the Congo and Sudan, where mining assets are plentiful. In the DRC, about two million "creuseurs" are believed to provide around 90% of all mineral output, employing almost twelve million dependents (Mallo, 2012; Matiko & Mullu, 2025). As in Sudan, artisanal mining in the DRC uses relatively primitive technologies and manual labour to extract minerals such as cobalt, gold, and diamonds. Sudan also has a long history of gold placer mining along the banks of the Nile (Mulenga et al., 2024; Radley, 2024). Currently, local people conduct this type of mining seasonally and rely on it for subsistence. Importantly, ASM in these countries is characterized by extremely high levels of informality, with easy entry making it popular among refugees from conflict zones, victims of economic depression, and former agriculturalists who cannot maintain their livelihoods (Rusdiana et al., 2025; Schwartz et al., 2021). Because of the mobility associated with ASM, governments have considerable difficulty controlling this economic sector.

The increase in ASM activities within hard-rock deposits has led to even greater reliance on mercury, deepening the sector's dependence on informal networks (Ukhurebor et al., 2024). In the DRC and Sudan, gold panners have traditionally focused on alluvial deposits; however, the shift toward vein mining has made motorized equipment and chemical amalgamation methods necessary (Mukhlis et al., 2024; Altieri, 2025). This transformation is facilitated by unscrupulous intermediaries and gold collectors who profit from black-market mercury trading and keep miners indebted. These collectors wield great power because they remain the only suppliers of mercury used in gold extraction (de Failly et al., 2013; Gallo, 2012). Government strategies to address informality in mining are inconsistent and have oscillated between military clearing and indifference. In Sudan, the Mining Act 2012 creates a legislative framework for formalizing the sector; however, customary tenure continues to govern access to minerals and thus coexists with government regulatory authority (Galantich, 2019; Geenen, 2012). In the DRC, the 2002 Mining Code (2018 revision) recognizes ASM, but it lacks the capacity to manage the numerous ASM sites.

Mining activities in both the DRC and Sudan cause enormous ecological damage, leaving an irreversible mark on their ecosystems. Intensive mining has caused major soil erosion, destruction of riparian zones, and landscape degradation in Katanga Province, DRC (Nyabola & Wachira, 2024). One key problem is mercury pollution, which occurs in large quantities because gold mines in the DRC use up to fifteen tonnes per year. This substance undergoes methylation and bioaccumulation and poses a serious threat to people who use nearby rivers for drinking and fishing (Galantich, 2019; Gimba, 2024). Another country suffering from such activities is Sudan; especially in Darfur, where ninety percent of houses utilize wood biomass. Additionally, mining leads to mass deforestation because EIAs were not conducted beforehand, leaving many areas deserted and without proper restoration (Hilson et al., 2018; Aidonojie, 2023). Moreover, contamination of streams during rinsing processes causes heavy metal exposure among the locals, as there are no alternative sources for drinking water.

The legal regime surrounding mining in these territories is often a patchwork of diverse legislation that struggles to align with environmental laws. The problem arises

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because, although the 2018 DRC Mining Code and Sudan's Mining Act 2012 include safety and hygiene regulations, neither provides a strong government regulatory mechanism to enforce compliance (Nteranya & Mukulia, 2024). In the former, the SAESSCAM agency responsible for overseeing mining activities in the Congo is significantly understaffed, making it easier for miners to be exploited by corrupt government officials and armed entities (Anani et al., 2023; D'Souza, 2005). The law is clearly inefficient at protecting people's right to a healthy environment, as environmental agencies are involved in the licensing process only after the damage has been done. Besides, current mining regulations are mostly repressive and more concerned with revenue collection than with land management practices (Kpokro, 2025; Hilson et al., 2018). A "large-scale mining bias" is evident in the government's preference for foreign multinational contracts over artisanal mining (Geenen, 2025), thereby forcing these miners to turn to illegal practices.

This research's innovation lies in its comparative study of how informal regulatory deficiencies in the DRC and Sudan negatively affect the environment in conflict-prone areas (Laudati, 2013; Katz-Lavigne, 2024). Whereas past literature has widely covered the social and economic factors contributing to the spread of ASM, this study seeks to explain how the failure of "hard law" regulation to address the cross-border links enabling environmental crime, such as mercury smuggling, has been largely overlooked (Onditi, 2022; Prescott et al., 2022). The study addresses the need to connect international environmental soft law, such as the Minamata Convention, to states' mining codes and their application in rural mining areas. Specifically, it examines how the "my-sharism" corruption system and limited technical capacity within government agencies fuel ecocide in the region (Trezor, 2021; D'Souza, 2005). In addition, this work offers a novel understanding of the role of formalization in securing the environment by focusing on the dilemma between sovereignty and international human rights.

This paper assesses the effectiveness of existing regulatory mechanisms in the two countries in protecting the environment from the negative impacts of mining activities (Kpokro, 2025; Mallo, 2012). This will be done by analyzing gaps in the current legislative system that allow informal-sector miners to use mercury illegally and cause deforestation. The objectives of this paper include analyzing international mining codes and South African practices to determine whether they could serve as models for reforming mining legislation in Central Africa. Other objectives include assessing the interrelations between mining codes and sectoral land and forestry laws and proposing a harmonized legal framework for the sector. By establishing the nature of informal entrepreneurial relations in the region and the reasons for their creation, this paper aims to propose appropriate recommendations to promote the implementation of miner-centric formalization strategies in both countries.

2. Method

For this study, a doctrinal methodology based on a review of the literature on the legal framework of informal mining within the DRC and Sudan has been adopted. The key source material for the primary doctrinal research has been gathered by collecting basic texts of law, such as the DRC Mining Code of 2018, the Sudanese Mining Act of 2012, and the constitutions of both nations. Secondary sources were identified through an extensive search of bibliographic

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databases, including scholarly journals, PhD theses, and publications from global organizations such as the World Bank and IIED. Through this systematic process, a robust body of literature has been developed that covers the laws and socioeconomic realities of Central African mining nations. The study uses qualitative doctrinal legal analysis to examine lessons learned from mining law implementation. Through black-letter law analysis, the study examines the law versus its implementation, identifying application conflicts that result in an environmental legal stalemate. The comparative analysis compares the DRC and Sudanese regulatory systems with international standards and other comparative jurisdictions, such as South Africa, to identify possible reform models. Thematic analysis also helps organize the research findings by their relevance to political, economic, or environmental factors. Analytical tools such as SWOT and PESTLE help clarify the relationship between the identified problems and the rule of law.

3. Results and Discussion

3.1. Adverse Effects of Carbon Emissions on the Environment and Public Health Safety

In the Democratic Republic of the Congo, ASM contributes significantly to GDP and employs about two million miners, commonly referred to as creuseurs. It accounts for almost 90% of the country's mineral production, including cobalt, gold, and diamonds (Konguka & Ayugi, 2022). Despite this enormous production, the sector has high rates of informality. Statistics show that around 73% of the DRC population lives below the poverty line, while the country has an estimated 24 trillion in untapped mineral deposits (Banza Lubaba Nkulu et al., 2009). Unfortunately, most of the money earned from the exploitation of these minerals does not reach the local populations who are trapped in the vicious circle of survival mining.

The history of mining in Sudan goes back far, with placer gold mining along the banks of the Nile dating to 4000 BC. Presently, Sudan ranks among the continent's most important producers of gold through artisanal mining (Gimba & Charles, 2024). Artisanal mining in Sudan is typically seasonal and migrant-driven, with the rural poor mining gold during the dry season to supplement agricultural income, which dwindles during these periods. The Sudan Mining Act of 2012 attempts to regulate artisanal mining by setting aside cadastral units for artisanal mining and issuing mining licenses only to Sudanese nationals (Nteranya & Mukulia, 2021). In some areas, access to these minerals is regulated through customary tenures, creating a convergence between State and customary laws. Like the DRC, Sudan was involved in the Global Mercury Project, indicating the use of traditional gold-processing techniques without safety measures. The informal sector in both countries is defined by the use of crude equipment such as picks, shovels, and pans, and by manual processes devoid of mechanization (Konguka & Ayugi, 2022). In the DRC, laws often overlook customary land-ownership rights, forcing miners into illegal mining in areas reserved for large-scale industries owned by foreign investors. The "bias towards large-scale mining" in government policies makes it difficult for artisanal miners to join mainstream mining processes because they lack the capital to meet registration requirements (Katz-Lavigne et al., 2024). Registration procedures have become so cumbersome that they push more than 75% of miners into illegal mining. In this context, informal mining should not be seen as an absence of law but as defiance of exclusionary laws.

Social dynamics in the mining sectors of both the DRC and Sudan highlight major gender and age differences (Schwartz et al., 2021). In the DRC, 20% of artisanal mining workers are women (around 400,000 people), who mainly participate in mineral processing, ore washing,

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and auxiliary tasks such as cooking. Nonetheless, women suffer severe threats, including violence and sexual assault, and they are excluded from leading positions in mining cooperatives (Various authors, 2024). Moreover, the participation of children constitutes another serious problem: the current number of children working in artisanal mining is estimated to range between 800,000 and 1,000,000 in the DRC only. For example, in cobalt mining, around 35,000 children work in dangerous conditions to collect crucial minerals required for the energy transition. Due to these working conditions, the possibility of education is denied to them, which means they are condemned to a life of poverty. Lastly, the illegal smuggling of minerals sustains ongoing conflicts, especially in the eastern parts of the DRC. Illegal mining sites often fund militant movements and political rebels, with high returns on investment that keep them illegal (Nteranya & Mukulia, 2024). Some of the minerals illegally traded include coltan, gold, and diamonds, which are mostly transported to neighboring countries without paying the necessary taxes. In Sudan, because the government is ineffective at overseeing operations in the region, informal structures dictate how mercury and gold are distributed, with corrupt government officials participating (Rusdiana et al., 2025; Schwartz et al., 2021). The international price of gold helps sustain this trend. International programs such as the Kimberley Process, as well as tracking systems to identify mineral origins, have been unsuccessful because "governance through disorder" remains a defining factor in informal environments. Informal Artisan Mining Impact on the Environment in DR DRC and Sudan

The worst environmental impact of informal ASM operations in the DRC and Sudan is the extensive use of mercury to amalgamate gold. ASM operations account for 37% of anthropogenic mercury emissions worldwide, making them the largest contributor to this type of contamination (Mulenga et al., 2024; Radley, 2024). In the DRC alone, an estimated 15 tons of mercury are used each year, making the country the continent's second-largest mercury emitter. Mercury is employed to recover small gold particles from crushed rock; once the amalgam has been created, the amalgam is set on fire and burned in the open, sending mercury vapors into the atmosphere (Mallo, 2012; Matiko & Mullu, 2025). Studies in mining areas reveal that mercury levels are 15 to 45 times higher than what is seen in normal tropical environments. As the mercury enters the food chain through methylation, it poses serious threats to the nervous systems of living creatures (Ukhurebor et al., 2024).

Informal mining practices contribute significantly to deforestation and biodiversity loss, especially in ecologically sensitive zones in the DRC. Mining requires cutting down vast amounts of wood for tunnel supports, charcoal production, and establishing camps for miners (Mukhlis et al., 2024; Altieri, 2025). Mining activities occur inside protected areas such as Kahuzi-Biéga National Park and the Okapi Wildlife Reserve, putting endangered species like the Grauer's gorilla and forest elephants at risk. Once the mine has been exhausted, it is typically left behind, resulting in large-scale environmental damage in the form of open pits and dumps (de Failly et al., 2013; Gallo, 2012). Mining activities in the Katanga zone have caused land instability and loss of forest cover, reducing the area's ability to sequester carbon dioxide. Mining practices negatively affect SDGs 13 (Climate Action) and 15 (Life on Land) because, in the cumulative effect, numerous small sites that have not been rehabilitated cause ecosystem fragmentation.

The effect on the country's water supply cannot be overlooked since mining affects the hydrology of surface and groundwater systems (Nyabola & Wachira, 2024). In areas such as Kolwezi and Lubumbashi where mining activities take place, water is considered dangerous

Print ISSN: 3156-7185
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because of the high content of elements such as arsenic, cadmium, lead, and manganese. In artisanal mining, the washing of minerals in streams is prohibited in the Mining Code; however, this practice is common among artisanal miners due to the lack of regulatory measures, thereby increasing the danger from heavy metals for locals (Galantich, 2019; Geenen, 2012). River siltation and the destruction of riparian zones cause riverbanks to collapse and damage houses located close to the mines. In the DRC, discharges from hydrometallurgical enterprises contaminate water sources and food products, resulting in high blood lead levels in women and malformations in their babies (Hilson et al., 2018; Aidonojie, 2023). River mining and riverbed disturbances have led to the loss of aquatic life that fishermen relied on.

Firstly, informal mining greatly reduces food security because it competes with agriculture for land and pollutes soils. Where mining is common, arable land is being rapidly eroded as fertile soils are used up and converted into mines (Kpokro, 2025; Mallo, 2012). Many young farmers have stopped growing cocoa and other food crops and have started seeking "quick money" through gold mining. Soil mercury in informal mining areas may also be found at concentrations up to 179 times higher than US benchmarks for uncontaminated soil. Moreover, this contamination transfers to vegetation; in Tanzania and the DRC, cases were reported in which mercury concentrations were higher in the leaves of cassava plants and vegetables cultivated near mining operations (Anani et al., 2023; D'Souza, 2005). In addition, previous EIAs were not conducted on those lands; hence, soil degradation occurs that cannot be restored, rendering the land useless for agriculture in the future.

Long-term human health problems from environmental pollution become a "silent crisis" for mining communities. Apart from the problem of mercury poisoning, miners develop such illnesses as silicosis, lead poisoning, and respiratory complications as a consequence of inhaling dust on a daily basis (Laudati, 2013; Katz-Lavigne, 2024). Children of the Katanga district living near the mining zones have been found to have cobalt levels in their urine that exceeded the occupational limit value by up to 87%. High levels of lead in women who were about to give birth have led to pre-eclampsia, and babies are born with congenital defects (Konguka & Ayugi, 2022). Poor hygiene in mining communities enables the transmission of communicable diseases such as malaria and HIV/AIDS. Many injuries and illnesses caused by working conditions remain untreated because of medical isolation and limited access to medical services in these mining areas (Galantich, 2019; Gimba, 2024). The poverty-environment vicious circle implies that while the mining industry brings money to people, it destroys the same resources which enable human survival.

3.2. Regulatory Framework of Informal Artisanal Mining in DRC and Sudan

In both the Democratic Republic of Congo (DRC) and Sudan, the framework regulating informal artisanal mining is founded on the principle of permanent State sovereignty over natural resources. Under Article 9 of the DRC Constitution and Article 3 of the 2002 Mining Code, all mineral substances in the DRC's soil and subsoil are owned by the State. Likewise, under Article 8(1) of Sudan's Mineral Wealth and Mining (Development) Act of 2015, all mineral materials in Sudan belong to the State. This institutional backdrop creates a hierarchical management arrangement in which the State is the only party that can grant mining rights (Onditi, 2022; Prescott et al., 2022). In the DRC, Articles 109-114 of the Mining Code require the Minister of Mines to designate "Zones d'Exploitation Artisanale" where industrial mining is impractical. In Sudan, Section 4 of the Mineral Wealth and Mining (Development) Act of 2015 defines traditional mining as mining activities conducted using local means within

Print ISSN: 3156-7185
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prescribed areas. Despite recognition of the mining sector, these activities are often relegated to marginal spaces. Both countries have laws that prescribe strict requirements for national citizenship to join artisanal mining because it is an anti-poverty strategy for locals (Gimba & Charles, 2024). In Article 111 of the DRC Mining Code, artisanal mining cards are available only to Congolese citizens, who must also commit to following safety, hygiene, and environmental laws. Sudan is not far behind; Article 12(2) requires applicants for a traditional mining contract to be Sudanese citizens over 18. While this policy is meant to channel revenues from small-scale mining to local communities, it creates challenges for miners. In the DRC, artisanal mining cards are issued by the Provincial Division of Mines and are valid for only one year. Furthermore, Sudan's Regulation of Traditional Gold Mining (2012) requires miners to register their mined product and sell it at Bank of Sudan points. These regulations make it difficult for miners to operate legally.

Institutional oversight is complex and often disjointed. For instance, in the DRC, two institutions have the mandate: the Ministry of Mines and the Ministry of Environment (Trezor, 2021; (D'Souza, 2005), Nature Conservation and Tourism (MENCT). Under Ordinance No. 07/018, the President transferred mining-sector responsibilities, including environmental aspects, to the Department for the Protection of the Mining Environment (DPEM) in the Ministry of Mines. The problem is that this created overlap with MENCT's general competence. In Sudan, the central authorities in charge include the Higher Council for Mining (chaired by the President) and the Ministry of Minerals. A competent technical body, the Geological Research Authority of the Sudan (GRAS), also exists. Sudan relies on joint Federal-State coordinating bodies to manage jurisdictional overlaps that may endanger the organizational effort (Banza Lubaba Nkulu et al., 2009). Fragmentation and the resulting overlap in institutional oversight often create what is known as a governance gap. It is reported that the Parliamentary Commission for the Environment in the DRC lacks the expertise to assess sector policy.

Environmental protection is conceptually a crucial element of both sets of regulations. Under Article 53 of the DRC Constitution, one has the right to enjoy a clean and healthy environment, while Article 112 of the Mining Code requires artisanal miners to observe environmental standards (Konguka & Ayugi, 2022). Whereas, in the case of industrial mines, there is a requirement to prepare the "Environmental Impact Study" (EIS) and the "Environmental Management Plan" (EMPP) under Article 204, artisanal miners are expected to comply with a less complicated set of provisions, such as the preparation of the "Plan d'atténuation et de réhabilitation" (PAR) during the research phase (Katz-Lavigne et al., 2024). Similarly, Sudan's framework stipulates that anyone with a mining contract must safeguard the environment from pollution under Article 26 of the 2015 Act. In addition, Sudan also has the 2001 and 2008 Acts, which provide for legal safety nets against environmental pollution. Sudan is equally committed to various international conventions such as the Minamata Convention on Mercury. The stringent legal provisions notwithstanding, the "informal" character of artisanal mining makes it difficult for these protective articles to be put into effect.

These laws have several sanctions meant to discourage any environmental degradation or illegal behavior. In the DRC, the Ministry of Mines is authorized to withdraw the artisanal card as per Article 114 if a mine operator fails to fulfill certain safety or environmental requirements. Non-compliance with hygiene and safety standards is subject to penal servitude and monetary fines according to Article 306. Unlawful mining operations not sanctioned by the relevant

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authorities are met with stiff fines of between 10,000 and 250,000 US dollars. Under Article 18 of the 2015 Act, Sudan has sanctions that allow for the revocation of contracts or licenses for breaches of the obligations or conditions set out. If mining operations cause adverse effects such as health hazards or damage to the natural environment, Article 28(1) grants authorities the power to cease operations. In Sudan, extracting minerals without a valid contract carries a prison sentence of up to three years. However, a synthesis of the punitive measures shows a gap between what the law states and what happens on the ground. In the DRC, the DPEM lacks the ability to monitor mining sites.

Nevertheless, analysis of the DRC and Sudan regulatory regimes shows that, despite their broad Scope, the legislation is flawed in its application. Both regimes emphasize centralized governance through licensing; however, they do not address the socioeconomic peculiarities of the ASM sector. Firstly, it should be noted that the framework law on the environment in the DRC is still in draft form; thus, the only legislative act in this regard is a Ministerial Order. In Sudan, although the Minerals Wealth Act (2015) has been modernized, the artisanal mining sub-sector is mainly regulated through "intervention campaigns." Moreover, another flaw in the existing frameworks is their excessive bureaucracy. The Mining Regulations of the DRC can be regarded as "extremely onerous" because their complexity makes compliance difficult. Finally, what makes a difference between the two frameworks is the fact that artisanal mining is treated as a traditional temporary occupation which should be strictly controlled; hence, neither country considers it to be an established economic practice that needs appropriate and comprehensive environmental governance.

3.3. Regulatory and Socioeconomic challenges

Among the main regulatory issues in the DRC is the lack of institutional capacity and funding at the Department for the Protection of the Mining Environment (DPEM). Even though this organization employs 40 people in Kinshasa, and 55 people in its provincial branches, it does not have an impact since it lacks office furniture, transportation, and analysis labs (Nteranya & Mukulia, 2021). This problem prevents experts from reaching remote locations where informal mining occurs to conduct inspections or ensure compliance with the environmental plan (Schwartz et al., 2021). In Sudan, problems with the organization of regulatory bodies can be categorized as legal, socioeconomic, and environmental protection issues. The country already has joint ASM organization councils; however, out of the 109 planned councils, only 89 were functioning in 2015. This makes it very challenging to enforce rules, such as limiting miners to their area of operations. Because the government cannot maintain stable control, unregulated mining becomes more popular (Kpokro, 2025; Hilson et al., 2018). Therefore, even though primary legislation and environmental acts prohibit environmental damage, they cannot be enforced because the government fails to regulate the process.

Both nations' regulatory systems are plagued by overlapping jurisdictions, which impede effective environmental management. The DRC faces a specific conflict between the Ministries of Environment (MENCT) and Mining. Ordinance No. 07/018 mandates that the Ministry of Mines oversee environmental matters in the mining industry, which clashes with MENCT's overall environmental jurisdiction (Geenen, 2025). As a result, policymaking lacks synergy, leading to conflicting laws. Sudan has had similar difficulties in federal-state relations. Although measures exist to address overlapping jurisdictions, sharing royalties and taxation between State and federal administrations has been problematic. Additionally, Sudan faces the challenge of

Print ISSN: 3156-7185
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having multiple laws governing its artisanal mining industry, including the Labour Act, Child Act, and Environmental Health Act (Various authors, 2024). However, these laws require inter-agency collaboration that has not always materialized. Thus, overlapping jurisdictions have led to a "siloed" governance structure, in which mining production takes precedence over environmental health concerns. Without a cohesive regulatory framework, artisanal miners cannot identify proper standards and therefore fail to comply with environmental laws and policies.

Onerousness is among the main barriers that mining regulations impose to formalization of artisanal miners (Mallo, 2012; Matiko & Mullu, 2025). In the case of the DRC, for instance, the Mining Regulations (Decree No. 038/2003) have been criticized for focusing excessively on procedural complexity rather than outcomes; hence, the regulations are almost impossible to audit. The onerousness discourages innovation and the adoption of superior technological extraction methods by small-scale miners (Rusdiana et al., 2025; Schwartz et al., 2021). As a result, most artisanal miners have opted to disregard the regulations and work entirely in the informal sector, paying only lip service to the law. In Sudan, miners face many administrative hurdles, especially fees for application processing and license issuance for traditional mining contracts (Mulenga et al., 2024; Radley, 2024). While these fees are aimed at organizing the industry, they may be prohibitive for poverty-stricken miners. Additionally, because artisanal mining in Sudan is highly migratory, enforcing a miner's obligation to stay within a specified area of operation is almost impossible.

The root causes of socioeconomic issues in the DRC and Sudan can be seen as severe poverty and underdevelopment (de Failly et al., 2013; Gallo, 2012). "Extreme poverty" was listed by the PNAE (National Environmental Action Plan) as one of the key drivers of constant environmental degradation in the country. For populations living in conflict-affected areas in the DRC, mining is usually the only viable economic option (Galantich, 2019; Geenen, 2012). Artisanal mining is characterized as "a poverty-driven activity" in Sudan. Estimates suggest that as many as 1 million miners worked in gold mining as of 2015, while 4 million people depended on the industry's profits. This accounted for approximately 14% of Sudan's overall population (Mukhlis et al., 2024; Altieri, 2025). To address environmental problems related to the practice, authorities may face social turmoil and unrest among the millions of Sudanese who earn their livelihoods through mining operations. Analysis of Sudanese miners revealed that only 7.5% of respondents were unemployed before taking up mining, making it a lucrative occupation.

One socioeconomic problem in Sudan is the movement of the workforce from agriculture to artisanal mining. This has driven up farm labour wages, from SDG32 in 2011 to SDG80 in 2013. Sectoral shifts reduce farmland, lower crop production, and cause food shortages, thereby reducing export volumes (Galantich, 2019; Gimba, 2024). About 38% of artisanal miners in Sudan were farmers before entering the mining business. This creates a dual threat to the nation: reduced food security and increased environmental destruction from mining. For instance, in the DRC, soil depletion in high-population areas is a main concern in PNAE. The heavy focus on gold mining in Sudan, which accounts for about 85% of total mined gold, leads to neglect of other mineral resources and agricultural activities (Hilson et al., 2018; Aidonojie, 2023). As such, the gold-based economy makes it easy for smuggling and market price fluctuations to adversely affect miners' socioeconomic status.

The environmental and health impacts of artisanal mining pose a significant challenge, linking regulatory and socioeconomic issues. In Sudan, most gold miners use mercury

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amalgamation (Anani et al., 2023; D'Souza, 2005). As a result, when they burn the mercury, mercury vapour enters the air and contaminates water sources, food items, and animals. There are ways to mitigate mercury contamination; however, implementing these measures is difficult because miners lack knowledge of the methods involved and lack appropriate technology (Laudati, 2013; Katz-Lavigne, 2024). Miners experience the negative effects associated with mining, such as exposure to harmful materials, including dust and gases. In both cases, poor hygiene and inadequate healthcare facilities contribute to health issues among miners. Although laws such as Sudan's National Public Health Act 2008 forbid selling toxic tools or clothing items, they are rarely enforced in temporary mining zones. Miners are mostly young people (under 45 years old) and cannot protect themselves because they lack knowledge of safety measures.

Conclusion

First, the institutional frameworks for artisanal mining in the DRC and Sudan show significant discrepancies between legislative intent and enforcement. Both countries have developed comprehensive mining and environmental laws (Law No. 007/2002 in the DRC and the 2015 Mining Act in Sudan), yet the effectiveness of such legal regimes is hampered by institutional weakness, a lack of financial resources, and conflicting roles of relevant ministries. Indeed, in light of the economic situation and the existence of millions of impoverished people who turn to mining to earn a living, there is an overwhelming incentive to resort to illegal mining activities that cause environmental harm due to excessive use of mercury and destruction of lands. In this respect, the two governments should coordinate mining and environmental regulations to resolve problems associated with conflicting jurisdictions. In addition, institutional strength should be ensured via budget allocations for provincial monitoring bodies and scientific laboratories. Moreover, there is a need to shift from repressive measures to assistance and "formalization," including technical support for mercury-free mining and micro-credits for rural miners.

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Conflict of Interest

Nil

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