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Safeguarding global health security amidst a scramble for Africa's minerals for the clean energy transition

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Abstract
The global transition to renewable energy is increasing the demand for critical minerals mining in Africa. Without appropriate safeguards, expansion of mining operations on the continent increases the risk of mining-associated infectious disease outbreaks with epidemic and pandemic potential.

Main text

The world is undergoing a rapid transition to renewable energy to meet the 2050 net-zero emissions target. This transition requires a stockpile of critical minerals like cobalt, copper, lithium, nickel, and rare earth elements. In many countries like the United States (U.S.) and European Union (EU) member countries, there is a risk of critical minerals supply chain disruptions, resulting in an increased demand for critical minerals mining on the African continent, where about a third of the world's known critical minerals reserves are found [1]. Extensive mining activities on the continent have historically been associated with human and environmental health and occupational hazards including air and soil pollution, contamination of community water sources, and elevated exposures of mine workers and communities to toxicants from mine residues resulting in adverse health outcomes [2–4].

Over the years, much attention has been garnered about the need for responsible mining policies and standards to address these concerns, which remain crucial, especially given current projections about increase in demand-driven mining activities associated with the clean energy transition [5]. For instance, by 2035, when the sales of petrol and diesel-operated vehicles are expected to cease in some U.S states [6] and across the EU [7], the demand for critical minerals is projected to far exceed available supply [8]. In response to the increasing demand for these highly sought-after commodities, country governments are mapping out policies and strategies to secure critical minerals supply chains, including strategies for expanding operations in minerals-rich African countries. However, the impetus to expand such operations poses a major global health security threat considering the often neglected and unheralded biosecurity risk posed by new outbreaks of mining-associated infectious diseases on the continent.

The current need and increasing global health security threats

There is a global need for a resilient supply of critical minerals to develop the required technologies as key enablers of the clean energy transition, including sustainable transportation systems, electric vehicles, solar panels, wind turbines, and grid battery storage. As a supply chain diversification strategy, many countries are

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Table 1 Projections on increase in critical minerals demand for clean energy technology under a net-zero emissions by 2050 scenario [data expressed in thousand metric tons (Kt)]

Energy transition Critical Mineral	2025	2030	2035	2040	2045	2050
Cobalt	136.8	205.4	248.8	258.5	285.2	290.7
Copper	8310.1	15731.6	19518.5	20678.1	19091.6	17351.4
Gallium	0	0.2	1.0	5.5	4.5	5.0
Lithium	254.1	628.4	1043.8	1187.4	1257.9	1178.5
Nickel	1658.9	3452.2	4309.5	4344.8	3966.2	3764.0
Platinum Group Metals (excl. Iridium)	0	0.1	0.2	0.2	0.2	0.1
Total rare earth elements	29.8	65	74.2	69.1	63.4	72.2

Data Source: IEA Critical Minerals Data Explorer [12].

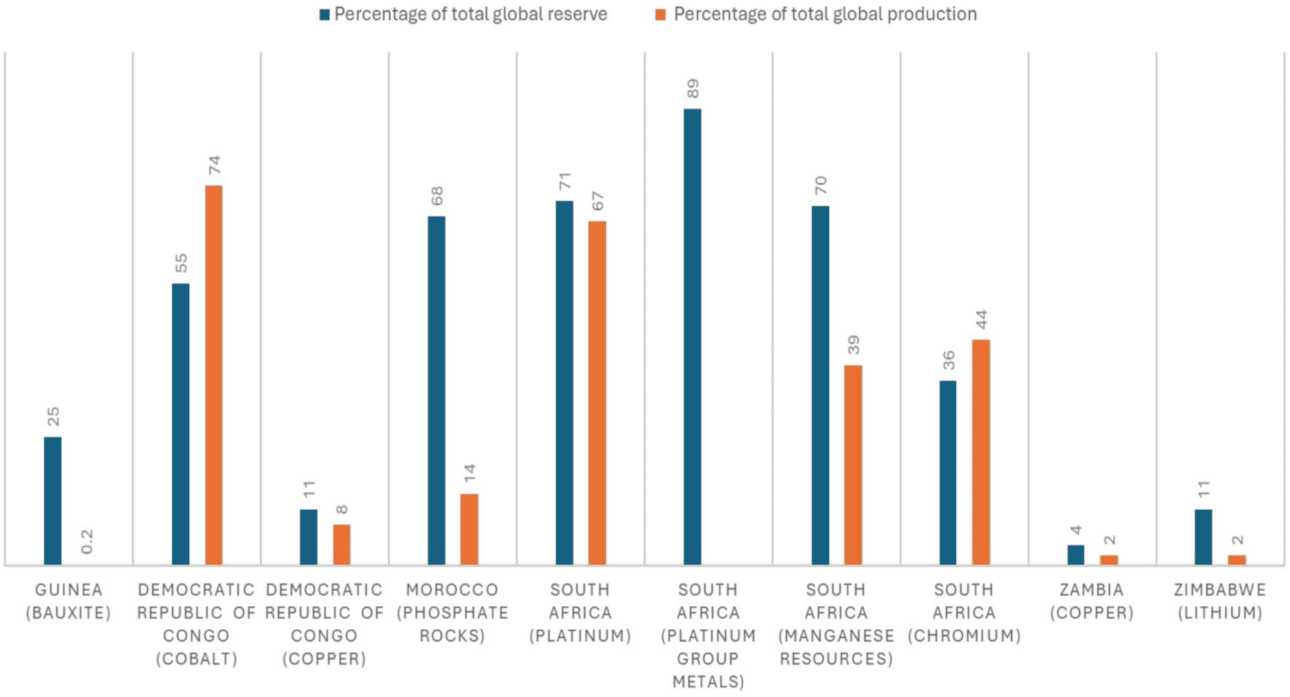

Fig. 1 Sources of select energy transition critical minerals on the African Continent. Data Source: US Geological Survey Mineral Commodity Summaries, January 2024 [10]

looking to regions with high reserves of critical minerals to keep up with the projected two-fivefold increase in the demand for critical minerals under the net zero emissions by 2050 scenario (Table 1). The African continent is home to a number of energy transition minerals listed on the U.S Department of Energy 2023 Critical Materials List [9], Geological Survey List [10], and the International Energy Agency (IEA) Critical Minerals Market Review 2023 [11]. In Central Africa, for example, the Democratic Republic of the Congo (DRC) is home to over 55% of Cobalt and is the world's leading Cobalt producer responsible for about 75% of global production; while in Western Africa, Guinea houses the world's largest reserve of Bauxite (the main source of Gallium and the primary ore used to produce Aluminum). Similarly, in Southern Africa, South Africa houses over 70% of the world's Platinum, and the largest untapped deposits of Lithium on the continent are found in Zimbabwe (Fig. 1).

Multilateral institutions like the World Bank and the World Trade Organization have provided frameworks for addressing vulnerabilities to critical minerals supply chain bottlenecks and the expected increase in mining-associated greenhouse gas (GHG) emissions [13, 14]. However, little attention has been given to the impact critical minerals mining could have on global health security including a heightened risk of infectious diseases/pathogens spillover, emergence/reemergence, and spread (SES). Several studies report a linkage between habitat encroachment associated with mining, logging, and extractives activities on the African continent similarly rich in species biodiversity, and outbreaks of emerging and/or reemerging infectious disease (EID) [15, 16]. Notably, a number of EID outbreaks that have occurred

Table 2 Infectious disease outbreaks and spillover events linked to mining operations on the African continent

Disease Outbreak/Pathogen	Year	Country	Transmission Source/Hotspot
Mpox Virus [20]	2023–2024	Democratic Republic of Congo	Kamituga Mines Area (ongoing investigations)
Ebola Virus Disease [19]	2018–2019	Democratic Republic of the Congo	Biakato Mines Area
Marburg Virus [18] Disease	2007	Uganda	Kitaka Mines
Human Immunodeficiency Virus [22]	2007–2018	Multiple countries in Sub-Saharan Africa	Multiple mines
Marburg Virus Disease [17]	1998–2000	Democratic Republic of the Congo	Goroumbwa Cave
Ebola Virus Disease [28]	1994	Gabon	Mekouka Gold Mining Camps

on the continent over the last three decades have been conclusively linked to mining activities (Table 2), including gold mining in Goroumbwa cave in the DRC (1998–2000) [17]; gold and lead mining in Kitaka mines in Kamwenge district of Uganda (2007) [18]; and mining in Biakato Mines area in the DRC (2018–2019) [19]. Recently, the emergence of a more severe strain of the ongoing 2023 Mpox outbreak in the DRC has been traced to the Kamituga mining area in Eastern DRC, according to findings from a new study under preprint by the Mpox Research Consortium [20]. There are also reported increase in EID transmission risks and antimicrobial resistance due to mining-associated socio-ecologic factors [21, 22]. Although the highlighted examples of mining-related outbreaks are not specific to energy transition minerals, the bone of contention is that without appropriate safeguards in place, encroachment on the natural habitat of pathogen reservoir host species for mining-related activities, irrespective of mineral type, increases the risk of pathogen/disease SES.

As an illustrative example, the Egyptian rousettes (fruit bats) are known to roost inside and along the periphery of caves and mines as their natural habitat and serve as a reservoir host species of a diversity of both known pathogens like Marburg virus and unknown pathogens [23, 24]. Anthropogenic activities such as mining in these areas contribute to an increased risk of pathogen spillover from fruit bats to humans [25]. A lack of appropriate health security safeguards to address increasing mining activities could also increase the risk of an unknown "Disease X" outbreak with epidemic and/or pandemic potential. Climate change is further increasing this risk by causing the migration of bats away from their natural habitats to more favorable habitats resulting in a risk of disease emergence and spread to non-endemic areas lacking population immunity, and heightened potential for sustained human-to-human disease transmission [26, 27].

Policy recommendations for improving environmental, social and governance standards to address mining-associated global health security threats

Responsible critical minerals mining must account for the associated biosecurity risks and global health security threats that could potentially arise due to encroachment on the natural habitat of EID pathogen reservoir host species. However, none of the over 450 policies listed on the IEA Critical Minerals Policy tracker explicitly address the need to incorporate biosecurity and health security safeguards into environmental and health impact assessments, in line with key recommendations from a related study [29]. Industry regulatory authorities must put in place appropriate Environmental, Social, and Governance (ESG) standards and regulations specifically tailored towards reducing health security threats, while holistically protecting the environment, and safeguarding the lives and livelihoods of miners and local communities. Recognizing that most countries globally have enacted strategic environmental assessment policies that mandate the conduct of environmental impact assessments (EIAs) or similar versions, a viable policy option is to expand these policies to account for biosecurity risk ad health security impact under EIAs of high-risk programs.

Different governments are actively working on expanding mining operations, including through the Mineral Security Partnership (MSP), which has announced 23 projects with 13 project sites on the African continent [30]. The MSP is a partnership of 14 countries (Australia, Canada, Estonia, Finland, France, Germany, India, Italy, Japan, Norway, the Republic of Korea, Sweden, the United Kingdom, and the U.S.s) and the EU that aims to accelerate public and private investment in responsible critical minerals globally by diversifying the critical minerals supply chain [31]. Given the aims and current priorities of the MSP, there is an urgent need for regulatory authorities including in the U.S., EU and the African Union (AU) to develop and implement policies and frameworks for conducting a SES risk analysis under EIAs to inform the implementation of biosecurity risk mitigation measures as a responsibility of the mining and extractives industry [32]. This newly proposed approach to risk analysis warrants adopting a comprehensive framework that incorporates multiple dimensions of risk in the context of mining operations. For example, using an integrated approach to characterize the risk of mining-associated pathogen/disease SES associated with cobalt and copper mining in the DRC, the recommended risk analysis should account for environmental drivers of EID outbreak risk, behavioral and socioanthropogenic factors that increase population vulnerabilities, and systemic lack of coping capacities that contribute

to cross-species spillover events and sustained human-human disease transmission [32]. This information must subsequently be used by applicable regulatory authorities like the U.S. Environmental Protection agency (EPA) and the DRC Agence Congolaise de l'Environnement (ACE) with the support of the AU Africa Centers for Disease Control and Prevention (Africa CDC) to identify corrective actions, and risk mitigation and communication interventions that must be put in place as a responsibility of the mining and extractives industry.

To promote consensus building and collective policy action against mining-associated health security threats, there needs to be a diverse representation of stakeholders as members of the MSP. These stakeholders must include African country governments and technical agencies like the Quadripartite institutions comprised the Food and Agriculture Organization, United Nations Environment Programme, World Health Organization, and World Organisation for Animal Health. As a priority area for policy action, the Quadripartite has identified the need to work with countries to sustainably enhance the prevention of pandemics and health threats at the source of emergence by targeting activities such as mining and other anthropogenic activities that increase the risk of cross-species zoonotic pathogen spillover [33]. Thus, these stakeholders should advocate for, mandate, and provide guidance on ESG standards and policies that account for health security threats and biosecurity risks as part of the MSP's guiding Principles for Responsible Critical Minerals Supply Chains [34].

Globally, future iterations to the draft of the Pandemic Prevention, Preparedness and Response Accord (referred to as the "Pandemic Accord/Agreement") under negotiations should address the need for a pathogen SES risk analysis under EIAs and ESG standards. This recommendation is in line with the scope of the Accord to jointly work together across all facets of society to support prevention, detection, and response to disease outbreaks with pandemic potential. As part of the Accord's compliance mechanisms, integration of SES risk analyses into EIAs could help address gaps in global pandemic prevention, preparedness, and response (PPPR) arrangements at the environment-animal-human exposure interface. A similar requirement should also be addressed under a common operational framework proposed for development by the newly established Panel on Critical Energy Transition Minerals working on incorporating issues around justice, equity, and sustainability in the energy transition [35].

Policies to enable the use of technologies for SES risk analysis

Policies that enable the use of earth observation-aided technologies for conducting SES risk analyses are required as critical safeguardsagainst mining-associated health security threats. To address data accessibility challenges, commercial earth observation (remote sensing) technologies should be leveraged for conducting data-driven SES risk analysis of the impact of mining and extractives industry operations. Specifically, remote sensing of environmental and climatological variables like land use changes and temperature anomalies could be utilized for mining-associated biosecurity risk modeling and to improve predictive and forecasting capacities using machine learning algorithms. This technology has been successfully utilized by the National Air and Space Agency (NASA) in different areas of public health including for tracking infectious diseases and environmental health hazards [36]. The application of remote sensing and other geospatial intelligence to assess and characterize the biosecurity risks posed by the increasing demand for critical minerals should include the development of an open-source database to ensure the availability and accessibility of relevant real-time/near real-time data for future scenario planning as part of EIAs.

To further characterize mining-associated emerging/reemerging pathogen threats, remotely sensed data could be combined with pathogen-agnostic sequencing data derived from shotgun metagenomics sequencing to improve the early detection of pathogens with epidemic and pandemic potential. Leveraging data such as information mapped by NASA's Earth Surface Mineral Dust Source Investigation mission [37] will also be crucial, to monitor emissions of GHGs such as methane associated with intensive mining and processing activities. This data could provide useful early warning insights into pathogen reservoir host migration patterns due to unfavorable habitat conditions. Mining companies and other relevant entities must use findings from risk analyses to develop and implement risk mitigation and preventive measures against mining-related health security threats and to limit further contributions to global warming.

It will take the whole global village

Many countries, including the U.S. and EU member countries, are working to diversify and improve the resilience of their critical minerals supply chain by expanding engagements in minerals-rich African countries. With the ongoing global race towards the clean energy transition and a scramble for critical minerals needed for the transition, policymakers and regulatory authorities like the AU, EU, U.S. EPA, and DRC ACE; members of the Quadripartite institutions; mining and extractives industry players and investors; and advocacy groups must ensure that ESG standards of mining and extractives industries effectively account for and mitigate global health security threats and biosecurity risks associated with critical minerals mining, especially on the African

continent. SES risk analysis must be robustly incorporated into EIAs as both a climate change mitigation and PPPR strategy. Having appropriate data-driven and technology-enabled global health security safeguards in place will require a concerted multistakeholder global effort to attain a net-zero emissions future free from epidemic and pandemic threats.

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Oluwayemisi Ajumobi conceptualized,drafted, and finalized the manuscript.

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Data availability
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Declarations

Ethics approval and consent to participate
Not applicable.

Competing interests
The authors declare no competing interests.

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