

Research Article

DOI: 10.62046/gijams.2026.v04i04.019

The Invariant Dynamics and Consequences of Nonferrous Metal Mining Operations on Health, Environment, Economy, and Geopolitics

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Received: 22.06.2026 | **Revised:** 18.07.2026 | **Accepted:** 20.08.2026 | **Published:** 29.08.2026

Abstract: This review explicates geopolitical issues and their impacts on nonferrous metal mining operations and the implications on the environment, health, economics, and global supply chains. The study explores the critical intersections of resource nationalism, environmental degradation, and economic impacts within the context of increasing global demand for critical minerals. This article is timely and pertinent, taking into cognizance extant global transitions toward green energy. The global issues associated with mining and metals are indicative globally of a vast majority of carbon-intensive sectors, and increasing demand for electronics and conventional produce culminating in the growth of metal and mineral production, as well as nonferrous metal mining activities in collaborative measures with numerous other perturbative and disruptive environmental and social activities via soil, water, air pollution, disease dissemination, climate change, environmental and economic distortions. Since prehistoric times, nonferrous metal mining operations have been facing complex and intricate metamorphoses driven by intense global geopolitical tensions, environmental demands and supplies, and the cravings for materials to undergird the green energy transition. The discourse pertaining to this article takes into account economic shifts within the sector, with highlights and hallmarks which impact geopolitical tensions on investment flows and operational costs. Invariably is the nuance that global trends have required reconfigurations of both industrial modalities and policy frameworks to embrace and improve environmental, health, social, and governance standards. Globally, nonferrous metal mining operations provide economic potential, stimulus, growth and jobs, community investments in development projects as well as enhanced anthropogenic economic impact. Conversely, nonferrous metal mining processes can negatively impact and degrade the environment through the destruction of biodiversity, contribute to the presence of hazardous chemicals or substances with resultant terrestrial, aquatic and atmospheric contamination and pollution enhanced by anthropogenic and natural activities. The inimical effects of mining include health perturbations, erosion, sinkholes, biodiversity loss, contamination and pollution of soil, groundwater and surface water caused by nonferrous metal and chemical emissions during and following mining operations. Furthermore, these processes adversely affect the atmosphere through emitted carbon contributing to climate change. The pivotal and primordial geopolitical issues, challenges, opportunities and priorities surrounding minerals and nonferrous metal mining processes are that geopolitical risks in the operational spheres are classifiable in disparate sections, such as resource nationalism, production concentration, processing concentration, landscape regulation, macroeconomic attributes and price volatility as well as expectations of stakeholder.

Keywords: sustainability, poverty, developing countries, industrial nations, climate, pollution.

Citation: Chrysanthus Chukwuma Sr. The Invariant Dynamics and Consequences of Nonferrous Metal Mining Operations on Health, Environment, Economy, and Geopolitics. Grn Int J Apl Med Sci, 2026 Jul-Aug 4(4): 368-379.

INTRODUCTION

This review tends to explore global geopolitical issues on the economics and environment of nonferrous metals mining operations. Sustainable development in nonferrous metal operations is exemplified by integrating health, economics, environmental, and geopolitical strategies. Since the local and global demand for metals is the predicate project to grow, industries implement specific, holistic frameworks in correlated trajectories with global initiatives and

expectations of stakeholders. In essence, global geopolitical issues, challenges, opportunities and priorities have reconfigured the health, economics and environmental parameters of nonferrous metal mining operations [1], with its metamorphosis from a supply-driven essence to that of an encompassing national strategic interest [2-4]. Within 2026, geopolitics aetiologically disrupted, distorted and fragmented markets via sourcing from allies or friend-shoring and onshoring modalities resulting in aggravated volatility

in supply chains. Thus, geopolitical spheres are basically transforming the nonferrous metal mining sphere, developing a high-stakes ambient whereupon economic sustainability and viability, supply chain security, as well as environmental, social, and governance (ESG) standards are in invariable flux. The invariable interest for critical mineral and nonferrous metal rush critical for the fuelling of the green energy transition has enhanced and potentiated resource-rich countries in the adoption of resilience [5] in resource nationalism, as principal consumer countries are poised on friend-shoring and local production with resultant rapid market fragmentation, disruption and distortion [6, 7], as geopolitical turbulence was indicative as a predominant factor constituting the trajectory of the mining and metals markets in 2025. Geopolitics that was dominant in mining and metals in 2024, continued to increasingly fragment markets in 2025 [8].

Geopolitics maintains the domineering factor impacting the mining and metals sector, evolving from a market with pivotal drivers to that of distorted fragmentation. Thus, mineral supply chains incessantly pursue the trajectory to fragmentation. Geopolitical anxiety and tension continuously drag countries in grabbing accessibility to vital resources and diminish reliance, perchance globally [9, 10], resulting in a clear and less disruptive decoupling of mineral supply chains and distorted patchwork of bilateral agreements, export inhibitions and limitations, import tariffs and direct commercialization to enhance stockpiles of pertinent minerals. These developments depend on spatiotemporal produce availability and concomitant wild swings in select markets. With combined accelerated technological progress, these transformations will create increased difficulties for project developers to access capital due to price fluctuations and unreliability and offtake projections, which may overwhelmingly benefit increasingly vertical integrated operators. Modern nonferrous metal operations incessantly undergo changes defined by integrating health, economics, environmental, developmental, and geopolitical strategies as the demand for metals increases, companies execute distinct, holistic frameworks in alignment with global insights and stakeholder prospects.

Economic Impacts on Mining Operations

Economic sustainability for nonferrous metals expects equilibrating the elevated capital costs of green innovation with fluctuations of market volatility and supply chain resilience. This article examines the interplay between global geopolitical dynamics and the nonferrous metal mining industry, with emphasis on environmental impacts, economic consequences, human health and strategic challenges. The research is positioned at the nexus of geopolitical tensions, resource nationalism, and imperatives of sustainable development. The main goals encompass examining the objectives of geopolitical shifts on mining economics,

regulations, and global supply chains. It is evident that geopolitical tensions have presented significant risks, issues, challenges, opportunities and priorities for mining economics as enunciated below: As of 2026, the sector is characterized by heightened strategic significance, where mining operations are increasingly used as tools of political leverage, impacting ecological sustainability and global economic dynamics. These are encountered in price volatility and supply disruptions due to escalating conflicts and trade barriers, such as tariffs and export bans) which produce and develop risk premiums driving prices upward for base and critical metals [11].

Due to strategic resource nationalism, nations having or intending to regulate, critical minerals such as, DR Congo for cobalt or China for rare earths are significantly on the implementation export restrictions, encouraging the development of cartels. Currently, strategic resource nationalism is accelerating, with pivotal and primordial producer countries leveraging export limitations to regulate critical mineral production and supplies, enhance local processing, and promote geopolitical leverage, as trending initiatives directly influencing supply chains for electric vehicles (EVs), defence technology, and renewable energy [12]. The intensified global shift in the direction of low-carbon energy systems has expansively accelerated demand for critical minerals, such as nickel and rare-earth elements, with unprecedented and unpredicted focus towards the resplendent and abundant reserves in Africa. Ardent geopolitical competitiveness triggered several countries to reconfigure mineral policies in the quest for supply-chain security, with re(emergence) by African governments to stringently regulate minerals and elevate domestic revenue [13]. Resource nationalism per Africa alienates from erstwhile spheres and trajectories of encompassing nationalization. Nowadays, policymakers tend towards a delicate balance within great-power expectations and competitions, employing price-responsive and fairly tailored interventions, and reconfiguring of transnational partnerships in convergence with other countries in order to evade excoriation of policy effectiveness, efficiency, efficacy and trust.

Investment shifts have predominantly become the trend of Western companies are shifting from high-risk geopolitical spheres to security-guaranteed ambients, whereas, particularly in Africa, it is notable that Chinese state-undergirded establishments incessantly expand at an accelerated pace, particularly in Africa. This has been observed in the prominent restructuring of global investment flows, featuring a divergent strategy between Western and Chinese establishments. In 2025, as global foreign direct investment (FDI) witnessed a 14% increase, rising up to \$1.6 trillion, it was mostly driven by volatile financial conduit flows other than recent, productive investment. Also, in 2025, FDI flows to developed economies escalated 43% to



\$728 billion, advanced by Europe and financial hubs. The European Union exhibited a 56% increase, undergirded by extensive cross-border procurements and a recovery in principal economies, such as Italy, France, and Germany. Conversely, flows to developing economies depreciated by 2% to \$877 billion, and the lower income nations were impacted the most, with 75% of least developed nations facing stagnation or retarding flows [14]. The 2026 Outlook presents unpredictability, uncertainty and fragility. In 2026, projection depicts aggregated and superimposed downside risks, with probable slightly increased exacerbated FDI flows, depending on financing conditions, continuous easement and rapid cross-border collaborations and procurements. However, real investment could remain suppressed, restricted by geopolitical tensions and stress, policy uncertainty and unpredictability as well as economic fragmentation. In the absence of coordinated functionality, global investment risks facing being systemically impacted in select precincts and regions.

Elevated operational costs govern or may be influenced due to compliance requirements with disparate domestic, national or regional standards, concomitantly with increasing energy prices influenced by geopolitics aggravating production cost. The confluence of rising energy prices regulated by geopolitics and the economic burden of compliance with prevailing local, national and regional conditions and standards are significantly raising production costs. These have caused the adaptation by manufacturers to a "new normal" of structural volatility, whereby elevated operating expenses (OPEX) directly pose a threat to profit margins [15]. With the fragmentation and geopolitical tensions of global supply chains recalibrate markets, companies encounter conventional sourcing modalities which lack adequacy. The World Economic Forum established that supply chains are witnessing a "structural volatility" era whereby disruption becomes a sustained characteristic other than shocks of spatiotemporal variations. This structural shift features geopolitical sourcing as a crucial business activity. A confluence of rising prices subsists as numerous disparate economic, structural, or geopolitical attributes interact, with resultant sustained or accelerated inflation encompassing an economy. In 2026, the phenomenon is especially evidenced in Nigeria as headline inflation and aggravated food price pressures are driven by an admixture of currency fluctuations, rising energy prices, and diminished local supply [16] due to the Gulf War between the USA-Israel and Iran.

Environmental Impacts of Geopolitical Shifts

This study tackles the intricate web of challenges and opportunities facing the nonferrous metal mining industry within the context of escalating geopolitical tensions, environmental repercussions, and economic considerations. The research elucidates how geopolitical dynamics such as resource nationalism,

production concentration, and supply chain security affect sustainability in the mining sector. It also examines the environmental impact of mining, emphasizing the ecological degradation and climate risks associated with nonferrous metal extraction. Geopolitical attributes influence environmental results by impacting where mining occurs and how intensively it is controlled. The geopolitical attributes basically tailor environmental occurrences in the mining sector by inducing the geographic extent of extraction in precincts with fragile governance and effecting the stringency of environmental controls. Frequently, rivalry for critical minerals culminates in "resource nationalism," wherein countries prioritize accelerated extraction more than environmental protection, potentially inducing toxic waste dumping and long-run ecosystem degradation. The mining repercussions on the environment could occur in regions, districts, and globally invariably by mining operations. Environmental impacts of mining may emerge due to mine destruction techniques, such as erosion of mine dumps, sinkholes, contaminants and pollutants encroaching surface water, groundwater and soil from chemical emissions due to mining operations and eradication of organisms [17].

Accelerated mining in weak governance ambients where the pursuit for essential materials frequently facilitates development in negligent environmental laws, culminating in elevated concentrations of adverse deforestation, water contamination and pollution, as evidenced in studies on artisanal mining. Accelerated mining in milieux presenting debilitated governance, driven by intensified global demand for critical metals, such as cobalt, lithium, and rare earths, is significantly associated with adverse environmental and social repercussions. Areas with lax environmental regulations or inadequate enforcement, usually in the Global South, the pursuit for these resources exacerbates deforestation, toxic water contamination and pollution [18]. The extraction of critical materials is pivotal for to achieve global clean energy targets but frequently results predominantly in social and environmental challenges, issues, opportunities and priorities, particularly in resource-endowed areas of the Global South. Although, extant studies highlight environmental and land degradation, social disruptions and degradations, including human rights abuses related to mineral extraction, an overall aggregate regarding how these interrelate and interact remain unclear and restricted. The concerns of "environmental dumping" versus strict regulations forces the Critical Materials Regulation (CRMA) of the EU to embark on stringent conformity or standards, although, certain countries may diminish environmental compliance in order to accelerate production and garner or access market share, and constructing fragmented global environmental standards [19] or compliance. The achievement of sustainable development in the low-carbon shift necessitates acquiring critical raw



materials, concomitantly diminishing environmental burden and enhancing industrial resilience.

Elevated carbon intensity to acquire supply, in concert with the application of energy-intense procedure, has transformed mining into a carbon-intense arena, that predominantly contributes to global GHG emissions among other spheres of production. The mining sector incessantly contributes significantly to global greenhouse gas (GHG) emissions, with estimates extending from 4% to 10% of global energy-influenced GHG emissions. The accelerated pursuit to acquire supplies, especially for critical minerals, has progressively advanced the application of energy-intense mining strategies, driving the carbon intense sector a significant concern to global climate goals [20]. Mineral resource depletion invariably influences energy consumption, impacting energy extraction, carbon dioxide intensity, and the sustainability of natural resource. Furthermore, it affects the potential of nations to reach their energy goals, and the capability to maintain environmental sustainability. It, therefore, becomes pertinent to ensure nations are accessible to the necessary minerals to extract and produce energy in order to diminish the effect of mineral resource depletion and depreciation of energy consumption.

Procrastinated reclamation and remediation as a result of astronomically elevated cost of compliance and the intense pressure on production, spur several companies to opportunistically prioritize extraction in lieu of attendant land reclamation and remediation, neglecting toxic tailings and degraded ecosystem cadastre. Retarded reclamation and remediation within the mining sector constitutes a widespread behaviour or tendency whereby negligence, operational pressure and elevated compliance costs and burdens cause establishments to be opportune and prioritize raw resource extraction than pertinent environmental cadastre rehabilitation. This strategy neglects significant environmental liabilities, including, but not limited to toxic tailings and severely degraded ecosystem cadastres which can persist for generations [21]. Facilitation is an important process for restructuring floral communities in degraded ambients. However, not much information is available regarding its contribution in promoting and improving tree recruitment in mine wastelands.

Indubitably, there are extant flaws in risk assessment [22], irrespective of the strategy, although, speculations are rife as to the aetiology of these untoward events. Within stringent legislation and regulatory modalities, it is evident that practitioners of risk assessment favour compliance beyond health, safety and ameliorating hazards when taking cost-benefit analysis in financial stance into cognizance. The gaps in information pertains in risk assessment, but the resolution of the conflict and speculations in aetiologies, strategies and trajectories depend on the systematic and strategic analyses, sentiment, characterisation nature and

implications of stakeholders as well as uncertainties enacted. This article enunciates the flaws inherent in risk assessment that tends to suppress equity and natural justice for a sustainable society [23], where there is the need for to re-orientation in the strategy for present and future society in the mining industry.

Trends in Non-Ferrous Metals

The nonferrous metal sector is undergoing a historic rally, for instance, silver surge, gold breaking records, and aluminum maintaining a high-premium, tight-balance status, regulated or driven by geopolitical "risk-off" tendencies, anxieties and safe-haven purchase, especially in the Middle East [24]. The non-ferrous metal sector emerges as the unrivalled victor of incipient 2026, offering exceptional returns which have overwhelmed other main asset categories. Copper and aluminum as well as precious metals such as silver and gold, including the expansive nonferrous metals complex depicted a historic rally that market observers refer to as "the most dazzling star sector of 2026." The comprehensive guide exposes the prevailing non-ferrous metals markets status, the driving forces undergirding the outstanding performance, and the manner investors are capable of positioning themselves in the dynamic sector. Material substitution becomes necessary as prices for critical materials rise because of shortages, and industries are employing accelerated efforts to substitute rare materials with ubiquitous metals, such as substitute of aluminum for copper. Analytical reports from the inception of 2026 substantiates that industrial sectors are rapidly involved in material substitution to ameliorate the exorbitant costs and supply disruptions of critical elements. This trajectory pursued by the pertinence for supply chain resilience within geopolitical tensions and rapidly progressive demand from the green energy transition towards a shift from rare or high cost materials to greater abundance of cost-effective surrogates [25].

Geopolitical fragmentation features as the industry shifts from globalized supply chains to regional "chessboards" wherein trade, investment, and environmental standards are regulated by geopolitical alliances other than market efficiency. For the inception of 2026, this observation reflects the novel industrial and economic landscape where geopolitical fragmentation exceeds market efficiency as the primordial driver of supply chain, investment, and regulatory approaches. The global economy is transiting from a unified system to a multipolar, bloc-based formation, frequently perceived as "regional chessboards", predominantly governed by economic nationalism, security interests, and technological rivalry [26].

Climate Risks in the nonferrous Metals and Mining Sector

Nonferrous metals and mining encounter extreme climate risks, in conjunction with physical threats, such



as extreme weather debilitating infrastructure, water scarcity impeding processing, including permafrost thawing, transition risks, carbon pricing inducing inflation of operating costs and altering regulatory frameworks, as well as similar factors which are inimical to health, safety, production and supply or delivery chains, requiring adaptation. Mining and metals constitute certain aspects of global increasingly carbon-intensive sectors, and high demand for electronics and modern goods resulting in enhanced metals and minerals production. Mining activities are associated with other diverse deteriorating social and environmental consequences via terrestrial, aquatic and atmospheric pollution [27].

Mining activities are also aetiological agents in biodiversity dissipation grossly affecting flora and fauna, erosion, sinkholes, chemical and carbon emission which contribute to climate change resulting in threats, hazards and damage to human health. The mining activities contribute 4%-7% of global greenhouse gas emissions, and produce fossil fuels which are the greatest emitter of carbon dioxide, creating waste materials in air and water pollution [28]. Climate change can impact on physical threats to mines and workers, transport infrastructure, demand and supply chains. Also, the low-carbon transition may be associated with transition risks due to instances of response to determinants and implementation of amelioration and adaptation policies, opportunities and priorities for high metal and mineral demand and supply.

Climate-related opportunities are associated in the amelioration and adaptation to climate change which include resource efficiency, cost saving, adoption of low-emission energy sources, creating novel and newfangled products and services, nascent markets accessibility, and resilience building in tandem with the demand and supply chain. The mining industry has to devise sustainable management policies in response to risks associated with climate change in order to obviate unprecedented and unpredicted future hazards, extreme conditions and climate risks. Climate risk is the ability for climate change to negatively impact business, assets, or operational potentialities. The different types of climate-related risks encompass alterations in precipitation and extreme variability in weather patterns, rising mean temperatures and sea levels. The three primary types of climate risks are physical risks which are direct damage due to weather being risks related to the physical impacts of climate change. These arise from the direct effects of climate change on infrastructure and environment, transition risks which result due to shift to a low-carbon economy, and liability risks correlated to legal actions for negligence in addressing climate change [29]. These risks exert manifest financial, functionality, and esteem hazards to businesses, economies and infrastructure. There are two categories of climate-related risks. These are acute risks

which are driven by extreme weather events such as floods, hurricanes, and wildfires; and chronic risks: which are resultant impacts of long-run shifts in climate patterns indicated by rising sea levels, extensively protracted droughts, and elevated average temperatures. Three types of financial risks due to climate change are physical, transition and liability risk. The decarbonization of the portfolio of an industry accrues costs, that is a determinant of its vulnerability to transition risks. These are well-nigh impossible to accurately predict in the long-run. Contextually, mining industries of nonferrous metals must understand and take into cognizance how climate-related risks, challenges, issues, opportunities and priorities impact their financial performance and status sustainably. This article emphasizes that intense hydrologic cycles, driven by global warming and anthropogenic activities, augment risks of severe floods and droughts. This calls for incorporating structural resilience in addressing these critical environmental and health vulnerabilities. The study underscores that in the absence of action, climate change accelerates harmful hydrological changes, especially in mining precincts.

Leadership resilience in disease-associated nonferrous metal mining operations

Leadership resilience in the nonferrous metal mining sphere as applicable in geopolitical and infectious disease crises needs a transition from reactive cost-management to proactive, collaborative approaches that prioritize personnel health, community trust, demand and supply chain diversity. The COVID-19, AIDS pandemic and Ebola outbreaks depicted that mining companies with ardent and stringent local health system infrastructure, digitalized functional operations, and proactive community functionalities in high-risk precincts are capable of continuity maintenance and sustenance more than those in deficiency [5-7, 30], AIDS and other health system perturbations [31-33]. Geopolitical risk management entails regular updating of environmental impact and risk assessments [Chukwuma 2025d] to incorporate geopolitical volatility, regulatory modifications, and community impact for preparedness rather than mere response to distortions and disruptions. Long-run community health strategies need to be investing in shared infrastructure that undergirds domestic economies at expiration of mine usage for reclamation, remediation and mitigation, through the development and identification long-run resilience that ameliorates abrupt closures resulting from health, environmental, societal or political emergencies.

Nonferrous metal mining undergirds sustainable development through the integration of green, low-carbon technologies, encouraging recycling, and adherence to stringent ESG standards and compliance. ESG (Environmental, Social, and Governance) standards constitute frameworks which steer the report of companies on non-financial accomplishment, as well



as carbon emissions, labor practices, and board diversity to ensure accountability and comparability in the sustainability of business execution. Pivotal modalities include executing circular economic activities per recycling/reuse, reclamation and remediation of mining sites, diminishing energy consumption, and enhancement of community engagement in addressing human health, economic and environmental risks and performance [34]. Geopolitical convergence is essential to global connectivity, linking regions across continents, imperatively, the world. Any disruption or distortion to the infrastructure renders sustainability in widespread divergence, disrupting access to communication, financial systems, and international operations across multiple regions.

Perspectives of sustainability and geopolitical impacts on the nonferrous mining industry

This framework entails morality reduction as a pivotal attribute in development, taking into cognizance that human capital resources and survival require farming in protected spheres which frequently conflict, and integration with conservation and sustainable modalities. These tend to be the core Issues and challenges in Nigeria and other developing regions. [35]. Environmental degradation result from pollution due to oil spills, gas flaring, biodiversity dissipation, and climate-induced, water-related issues [36]. Anthropogenic activities and natural occurrences including other incidents related to the petroleum industry have broadly contributed to the contamination and pollution of diverse precincts of human habitat. There are newfangled remediation strategies which effectively and efficiently clean up contaminated and polluted shorelines and other petroleum-contaminated precincts meant inter alia for agricultural activities. Furthermore, there are perspicuous variations in the technologies to discard pollutants and contaminants considering spatiotemporal and financial costs, environmental hazards associated with health and development in the petroleum industry [36-38].

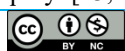
Banditry and conflicts in mining and agricultural precincts, especially in Nigeria, are inhibiting development and exterminating livelihoods [4, 32, 39]. Poor, rural infrastructure suppresses the mobility of goods, services and people, and impeding economic growth [40]. Development is hampered by pervasive corruption and ignorance as depicted in Nigeria through the diversion of resources from critical infrastructure and services [41]. An integrated policy planning implementing interdisciplinary policies which transcend political, legal, and economic peripheries are of pertinence [42]. Sustainable energy, green building, and sustainable agricultural ventures are correlated strategies to accomplish current needs without compromising future generations to enact their capabilities, while considering human and environmental health, economic viability, and social equity [23, 43]. The essence of local stewardship to

empower local communities for active participation in environmental Intergenerational equity connotes distributive justice between present and future generations with the right of the latter to inherit an environment that at the minimum as conducive as that of their predecessors, devoid of derangement being the resultant impact of current anthropogenic activities. It is pertinent to encourage protection practices associating conservation with quality of life and security. Local stewardship enhances communities in environmental management and conservation by encouraging ownership and sustainable approaches. It transcends up-bottom control to community-directed and citizen participation initiative [44-46] such as sustainable farming, agroforestry, or eco-tourism which abate resource pressure, augment biodiversity, and enhance income. The strategy endures long-run protection by equilibrating economic necessities with ecological health [47].

This framework predicates transition in perspective, with emphasis on sustained viability and intergenerational equity in lieu of fire brigade trajectories and profits. The enunciated framework conceptually and contextually adheres to sustainable development [23] that is reliant on intergenerational equity principle for sustainable development for the future [23, 48]. The critical minerals and elements are natural materials which have pertinence in contemporary life but exhibit insecure supply. The deficiency of a secure supply negates the increasing benefits of these substances, particularly with their application in technologies required to mitigate or diminish global carbon dioxide emissions and anthropogenically induced climate change [49]. Recently, global metal commerce has encountered elevated uncertainty resulting from evolutionary geopolitical occurrences and dynamics in economic policies [50]. As is also evidenced, environmental challenges and issues pertain arising from nonferrous mining operations in Nigeria and Cameroon with grave geopolitical concerns [51].

Pivotal dimensions of the study

Significant aspects of this research include implementing circular economic practices concerning recycling/reuse, reclamation and remediation of mining sites, diminishing energy consumption, and enhancement of community engagement in addressing human health, economic and environmental risks and performance. The study addresses interactions between environmental, economic, and health crises, challenges, issues, opportunities and priorities. It emphasizes that extant geopolitical dynamics conflict with sustainable development, necessitating collaborative effort and approaches for present and future wellbeing and welfare of humans. Geopolitical crisis [51] and competitiveness frequently aggravate environmental degradation and impede resource management and sustainability [22, 48]. This research argues for a shift or transition from



defined state-centric models, for a holistic trajectory that integrates environmental health with economic sustenance for a prolonged and advanced progress which advocate for wholesome and integrated global governance to supersede national polemics which inhibit crucial reforms in inter alia climate and health, to potentiate sustainable survival and quality of life. This work explicates that transcending beyond the extant geopolitical imbroglio significantly truncates ecological excoriation, and promotes equitable global future, to provide a multidimensional understanding of the sentiments of nations and global interactions [52, 53]. This study has ostensibly offered defined perspectives and reflections adapting to change crises transformation into opportunities and priorities, in consonance to overcoming challenges and issues.

The article investigates the multifaceted impacts of geopolitical dynamics on nonferrous metal mining operations, highlighting pivotal health, environmental and economic spheres. The study posits that geopolitical tensions, resource nationalism, and shifting economic policies predominantly impact mining practices and sustainability efforts [22]. It is argued that the increasing global demand for minerals necessitated in green energy transitions aggravates resource nationalism and economic fragmentation. The discourse inextricably links these issues to more expansive themes as well as governance fragility in resource-rich regions, investment shifts driven by geopolitical stability, and mitigating operational and risk assessment flaws [23] resulting from escalating energy costs and regulatory compliance.

DISCUSSION

Mining and nonferrous metals constitute certain aspects of global carbon-intensive sectors. The increasing demands for electronics and modern goods have enhanced metals and minerals production. Mining practices also result in diverse deranging human health, environmental, economic and social effects through soil, water and air pollution. Geopolitical risks in the mineral sector are classifiable in six significant spheres: resource nationalism. Concentration of production, processing. Concentration, regulatory landscape, macroeconomic factors and price volatility, as well as stakeholder expectations [52, 53]. In 2026, this categorisation explicitly incorporates the main geopolitical pressures impacting the global mining and mineral sector. These spheres reflect a transition from absolute economic decision-making to that immensely induced by national security, supply chain resilience, and health, as well as environmental, social, and governance (ESG) standards.

Mining is a grave aetiological factor for erosion, sinkholes, biodiversity loss, contamination and pollution of soil, groundwater, and surface water via chemical emission from nonferrous metal mining activities. These practices impact the atmosphere

through carbon emissions which contribute enormously to climate change [54]. This article narrates the persistent invariant socioeconomic, health and environmental challenges in Nigeria and developing countries through the lens of an ecological framework or analysis to depict the "poverty trap syndrome", and the pertinence for sustainable and integrated management. It emphasises that surmounting these impediments pave the trajectory in addressing systemic corruption, infrastructural deterioration, and environmental degradation, beyond the leveraging of local stewardship and holistic policies to thinking locally and acting globally [55]. Developing nations frequently become entangled in invariant challenges, intermittent, recurring, unpredictable and unprecedented environmental degradation and perturbation involving oil spills [37, 38], deforestation and economic stagnation which ingloriously advance into the "poverty trap syndrome," causing restricted development of vulnerable nations into accelerated poverty [56]. An ecological framework for sustainability and poverty eradication [57, 58] must incorporate a sustainable strategy that integrates ecological, social, and economic attributes beyond fragmented and sectoral trajectories to a holistic paradigm [59].

Effective management and opportunities identify the 80/20 rule or Pareto principle for intervention, diminishing or eradicating corruption, equitable distribution and unrestricted access to resources, with enhancement of the promotion of local environmental stewardship [60]. The sustainability issues in the mining industry encompass anthropogenic and natural activities during mine exploration, construction, and maintenance which may culminate in land-use change, with resultant deforestation, erosion, contamination, pollution and modifications of soil profiles of local, regional and global atmospheric, aquatic and terrestrial health and environments, as well as elevated noise level and pollution. The sustainability of nonferrous metal consumption can be enhanced to diminish or extinguish the environmental impact of extraction by decreasing nonferrous metal usage through more effective and efficient application, and offsetting increased demand via recycling and reuse to improve the overall sustainability of nonferrous metal consumption [61]. Locally, regionally and globally the mining industry tends to improve the environmental, economic and social performance of its activities. The effects of the mining industry on the environment in conceptual sustainability and human behaviour depict several negative impacts of mining activities. Certain instances include climate change, deforestation or habitat destruction, human-wildlife conflict, as well as the extinction of biodiversity. Prime or pivotal environmental, economic and social issues and priorities must be identified via quantitative and qualitative sources, as influenced geopolitically [62]. The entries explore the geopolitical crises intersecting



and interacting environmental degradation, economic pressure, and human health [63, 64] for a sustainable society to ensure human survival and quality of life [65]. The advocacy is pertinence for integrated, cooperative strategies as well as effective environmental policies and global collaboration essential to address intertwined and inextricably-linked challenges, issues, opportunities and priorities [1, 61, 62], with particular emphasis on disease-related [66-69] nonferrous metal mining operations.

CONCLUSION

Mining and metals constitute certain aspects of global most carbon-intensive sectors, and growing appetite for electronics and modern goods resulted in accelerated production of metals and minerals. Mining activities have incessantly and invariably culminated in diverse other degrading environmental and social impacts via soil, water and air pollution, as geopolitical risks in the mineral sector are essentially categorized in major areas, such as resource nationalism, concentration of production, concentration of processing, regulatory landscape, macroeconomic factors and price volatility, as well as stakeholder expectations. Mining can cause erosion, sinkholes, loss of biodiversity, or the contamination of soil, groundwater, and surface water by chemicals emitted from mining processes. These processes also affect the atmosphere through carbon emissions which contributes to climate change.

Global geopolitical challenges, issues, opportunities and priorities have reconfigured the economics and environmental management of nonferrous metals mining, transiting the sector focused on price efficiency to a "deal cycle" propelled by national security, trade limitations, and resource sovereignty. The intensive rivalry for critical minerals, induced by the energy shift and defence requirements culminated in increased supply level and high vulnerability to geopolitical shocks. Succinctly stated, geopolitical tensions are altering mining into a national security stance, distorting environmental compliance with requests and interests for accelerated, secure production. Geopolitically, non-ferrous metal, production and productivity supplies are geographically disseminated, wherein corporations having large market shares in pivotal segments or chains of non-ferrous metals dominate mining operations.

The study addresses interactions between environmental, economic, and health crises, challenges, issues, opportunities and priorities. It emphasizes that extant geopolitical dynamics conflict with sustainable development, necessitating collaborative effort and approaches for present and future wellbeing and welfare of humankind. Geopolitical crisis and competitiveness frequently aggravate environmental degradation and impede resource management and sustainability. This research argues for a shift or transition from defined state-centric models, for a holistic trajectory that integrates environmental health with economic

sustenance for a prolonged and advanced progress which advocate for wholesome and integrated global governance to supersede national polemics which inhibit crucial reforms in inter alia climate and health, to potentiate sustainable survival and quality of life. The work explicates that transcending beyond the extant geopolitical imbroglio significantly truncates ecological excoriation, and promotes equitable global future, to provide a multidimensional understanding of the sentiments of nations and global interactions. This study has ostensibly offered defined perspectives and reflections adapting to change crises transformation into opportunities and priorities, in consonance to overcoming challenges and issues.

Acknowledgement: None

Declaration: None.

Conflict of interest: None.

Source of fund: There was no financial source of support from outside.

Ethical Approval: None

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