POLICY BRIEF

Strengthening ESG Integration into Critical Mineral Supply Chains in Zambia: Lessons for Low- and Middle-Income Countries

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EXECUTIVE SUMMARY

Critical minerals are essential to renewable energy systems, electric vehicles, battery storage, and grid infrastructure. As global demand accelerates, many low and middle-income countries (LMICs) are expanding extraction and processing activities. However, weak regulatory capacity, climate vulnerability, and social conflict continue to expose mineral-rich countries to social and environmental risks such as labour vulnerabilities, community conflict, and climate-related disruptions.

Although Environmental, Social, and Governance (ESG) principles are widely referenced in mineral strategies and, in some contexts, mandated in the form of Community Benefit Agreements (CBA) and Environmental Impact Assessments (EIA), the lack of enforcement, monitoring, and transparency mechanisms undermines climate goals and regional development outcomes as mineral expansion continues.

Looking at the case of Zambia, this brief highlights the need to integrate ESG mandates directly into licensing systems, infrastructure planning, and revenue governance frameworks. Beyond protecting communities and ecosystems, integrating ESG requirements into licence conditions and oversight processes is essential to reduce production instability, strengthen investor confidence, and ensure mineral revenues contribute to long-term regional supply resilience. Zambia's experience shows that ESG provisions exist on paper but remain weakly enforced and weakly tied to licence conditions. The central argument of this brief is therefore that Zambia's challenge is not a legislative vacuum, but a law–practice gap: the problem lies in weak integration of existing ESG obligations into licensing, monitoring, renewal, and enforcement decisions.

The primary audience for this brief is Zambian policymakers and regulators, especially the Minerals Regulation Commission, Zambia Environmental Management Agency (ZEMA), relevant ministries, and parliamentary actors, while the analysis is also relevant to mining firms, financiers, and development partners concerned with responsible critical mineral governance.

Key Policy Recommendations

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Embed enforceable ESG requirements from the earliest stages of exploration and continuing throughout the mine life cycle and processing activities.

→

Mandate inclusive community participation and legally recognized consent mechanisms at every stage of exploration, mining, and processing.

→

Establish statutorily earmarked and independently governed mineral revenue funds that directly contribute to the wellbeing and development of mining communities.

→

Require climate risk assessments and adaptation planning across extraction, processing, and transport infrastructure.

Introduction

Zambia's mining governance framework contains several legal controls relevant to environmental, social, and governance (ESG) performance. These are grounded primarily in the Minerals Regulation Commission Act, 2024 [1], the Environmental Management Act, 2011 [2], and related statutory instruments on environmental assessment and pollution-control licensing [3,4].

These instruments address ESG in distinct ways. Environmentally, they regulate impact assessment, emissions and effluent discharges, waste management, environmental audits, and restoration orders [1–4]. Socially, they provide for public participation in environmental assessment, occupational safety obligations, and local community development objectives in mining areas [1]. From a governance perspective, they focus mainly on licensing integrity, reporting, inspections, enforcement powers, and regulatory coordination. However, broader concerns such as business ethics and anti-corruption remain only partially addressed within the mining-specific ESG framework discussed here [1].

Recent academic research documents persistent ESG vulnerabilities within Zambia's mining sector. Spatial ESG assessments of the Copperbelt highlight uneven environmental performance, exposure to water-related risks, and variable integration of social safeguards at the project level [5–7]. Community-level studies in mining regions such as Chingola report continued concerns regarding livelihood disruption, limited local benefit capture, and perceptions of inequitable distribution of mining gains [8]. These social pressures are often intensified where mining concessions intersect with customary land tenure, creating disputes over land access, compensation, livelihood restoration, and the authority of traditional leaders and affected communities. These Zambia-specific findings are consistent with the broader mining literature, which identifies weak institutional integration, fragmented oversight, and limited enforcement capacity as recurring constraints in mineral-dependent economies [6,9]. Together, this literature indicates that Zambia's ESG challenges are not isolated incidents but reflect structural governance and implementation gaps.

Although this brief focuses on Zambia's domestic mining framework, the analysis is also informed by relevant international soft-law standards that increasingly shape responsible mineral governance. These include the UN Guiding Principles on Business and Human Rights, the principle of Free, Prior and Informed Consent (FPIC) reflected in the United Nations Declaration on the Rights of Indigenous Peoples, the IFC Performance Standards on Environmental and Social Sustainability, and the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas. While these instruments are not directly binding in the same way as domestic legislation, they provide internationally recognised normative benchmarks for assessing community rights, environmental and social risk management, transparency, and corporate accountability in mining. The Zambia case should therefore be understood not only as a domestic regulatory challenge, but also as part of a broader international shift toward responsible and resilient mineral supply chains [10–13].

Furthermore, multiple independent and official audits, together with documented incidents and litigation, show persistent "law–practice" gaps driven by weak monitoring capacity, poor inter-agency coordination, inconsistent sanctions, and limited transparency. In a compliance audit of mining rights oversight (2017 accounts), only 12% of sampled exploration right-holders submitted required quarterly reports and there was no evidence of punitive measures against non-compliance, undermining the intended monitoring function of licensing [14].

Recent high-profile incidents and disputes, including the February 2025 acidic waste spill into the Kafue River, repeated mine safety failures prompting regulatory suspensions, and resettlement-related legal actions, illustrate how ESG obligations can remain effectively detached from licence administration in practice, because they are not systematically embedded into licensing decisions, renewals, suspensions, or modifications, even where the underlying legal obligations formally exist [15]. Zambia's mining governance framework is structured across multiple layers of legislation, regulatory instruments, and institutional oversight, as summarised in Figure 1.

While this framework provides a comprehensive formal basis for ESG governance, its effectiveness depends on how these instruments are operationalised in practice.

FIGURE 1

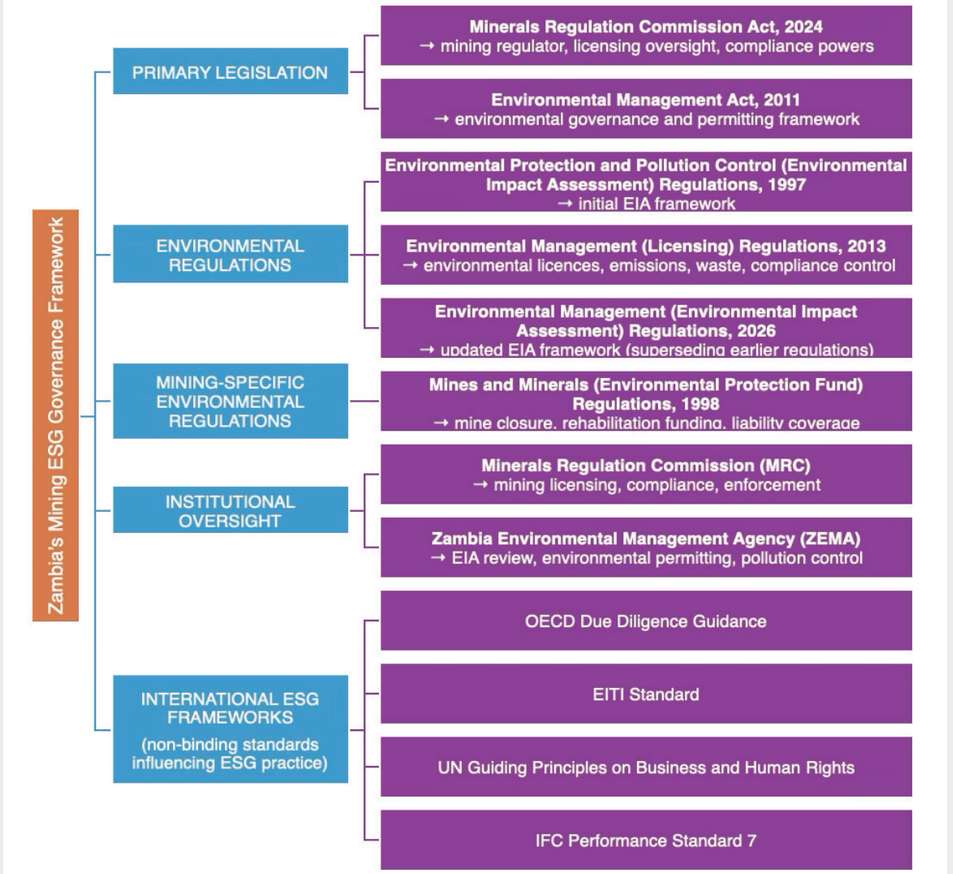

FIGURE 1. ZAMBIA'S MINING AND ENVIRONMENTAL GOVERNANCE FRAMEWORK (LEGAL HIERARCHY)

How Zambia's mining ESG enforcement system works in law

Across Zambia's mining sector, ESG-related compliance is governed through several linked legal controls that operate before project approval, during operations, and at closure:

- Environmental gatekeeping: mining and processing should not proceed without prior environmental approval through Environmental Impact Assessment (EIA) [1,2,4].
- Environmental operational control: pollution control licences under the 2013 licensing regulations govern emissions, effluents, waste management, coupled with periodic returns and inspection powers [3].
- Environmental enforcement and remediations: the Environmental Management Act provides compliance, prevention, restoration, protection, and cost-recovery orders, together with prosecution pathways and environmental audit powers [2].
- Social and occupational safety controls: the mining regulator has authority over accident and dangerous-occurrence notification, inspections, and suspensions for safety-related non-compliance [1].
- Governance and closure assurance: the system also includes compliance reporting, regulator coordination, and financial assurance for rehabilitation through the Environmental Protection Fund (EPF) framework [14,16].

Zambia's current legal and institutional framework for ESG in mining

Core mining and licensing statute

The Minerals Regulation Commission Act, 2024 [1] establishes a central mining regulator (the Commission) and sets explicit ESG-related licensing thresholds, including compliance with environmental approval as a legal precondition for exploration, mining, and mineral processing. In practical terms, this means the licensing system is intended to operate as more than a registration function: the regulator may inspect, investigate, suspend operations, and use licence-based enforcement where statutory requirements are not met. The governance dimension here is therefore primarily administrative and regulatory, including licensing integrity, inspections, reporting, coordination with other authorities, and enforcement action for non-compliance. However, the Act does not on its face provide a detailed mining-specific framework for business ethics, anti-bribery, or anti-corruption compliance; those governance issues remain important, but are addressed only indirectly through general public-law and oversight mechanisms rather than through a standalone ESG ethics regime in the mining statute.

The Act also frames mining as requiring "safety, health and environmental protection," and includes a stated objective of local community development around mining areas (as a guiding principle) [1]. In addition, it assigns the Commission functions that are directly ESG-relevant, including inspections and investigations on safety, health and environmental issues (in collaboration with other competent authorities), and monitoring or auditing environmental management and environmental budgets for progressive rehabilitation and mine closure (in consultation with the environmental authority) [1].

The Act sets out broad obligations and institutional powers, but it does not itself provide a detailed indicator-based ESG compliance framework for matters such as biodiversity performance, livelihood restoration quality, water-use efficiency, or safety metrics. Those issues are instead dispersed across environmental law, sector practice, licence conditions, and regulator discretion.

On paper, this creates a potentially strong enforcement architecture. In practice, however, later case studies and audit findings suggest that licence conditions, inspection powers, and reporting obligations are not consistently used to generate routine compliance evidence before incidents escalate or licences are renewed.

Environmental law, assessment, and licensing controls

The Environmental Management Act, 2011 [2] sets the overall framework for environmental governance. It requires environmental assessment approval for certain projects, including mining, and ensures public participation. It also establishes enforcement tools such as prevention orders, protection orders, environmental restoration orders, compliance orders, and cost orders. The Act also includes provisions for environmental audits and monitoring. For mining projects, environmental assessments must address key site-specific risks. These include land disturbance and land-use change, water abstraction and pollution, tailings and waste-rock management, hazardous substances, air emissions and dust, biodiversity impacts, community health and safety, and mine closure or rehabilitation.. Zambia's broader environmental framework also regulates air protection, emissions, discharges, effluent and wastewater, hazardous waste, and overall waste management. This supports a comprehensive, risk-based approach to environmental assessment in the mining sector [2].

The Act also provides for public participation and consultation within the environmental assessment process. However, the existence of formal participation requirements should not be equated with meaningful influence in practice. The key implementation question is whether consultation occurs early enough, with sufficient information and representativeness, to shape project decisions rather than merely document procedural compliance.

Under the Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations, 1997, listed projects cannot lawfully proceed unless the assessment process is completed and the competent authority issues a decision; the Regulations also require consultation during the assessment process and link mitigation commitments to subsequent monitoring, audits, and inspections tied to approval conditions [4].

Separately, the Environmental Management (Licensing) Regulations, 2013 operationalise ongoing environmental control after project approval through licences and compliance tools relating to emissions, effluent and wastewater, hazardous waste, and waste management [3]. This is particularly important for mining because water use, water contamination, and waste handling are core operational risks in extraction and processing. Zambia's environmental framework explicitly regulates discharges into the environment, atmosphere protection, and licensing for pollutant emissions, while ZEMA's licensing system includes emissions, waste management, hazardous waste, and pesticide or toxic-substance licences [2].

This also reveals an imbalance in the Zambian framework: environmental controls are comparatively more developed and legally specified than social safeguards. Beyond public participation, safety duties, and a general objective of community development, the law provides fewer explicit project-level social requirements on matters such as livelihood restoration, benefit-sharing, community consent, grievance mechanisms, or independent social monitoring. The legal toolkit is therefore substantial, but its effectiveness depends on inspection frequency, technical capacity, public disclosure, and follow-through on sanctions. The main weakness is not the total absence of legal powers, but the incomplete operationalisation of those powers in day-to-day mining oversight.

Notable update (2026): Zambia has replaced the 1997 EIA regulations with the Environmental Management (Environmental Impact Assessment) Regulations, 2026 (S.I. No. 3 of 2026), effective 9 January 2026. Available summaries indicate that the new regulations revise project classification, procedures, timelines, and fees. However, at this stage they should be treated as an important procedural update rather than, by themselves, proof of stronger enforcement; their practical significance will depend on how consistently ZEMA applies them in project review, monitoring, and follow-up [17,18].

Mine closure and rehabilitation assurance

Zambia uses an Environmental Protection Fund (EPF) as its principal mechanism for mine rehabilitation and closure. In simple terms, the EPF is intended to ensure that funds are available for environmental rehabilitation if a licence holder fails to meet its closure obligations, so that the state does not inherit unfunded liabilities [16]. Here, "rehabilitation" refers to the restoration, stabilisation, and risk reduction measures required to make mined land and associated waste facilities environmentally safer during closure and after operations cease.

Revenue and royalties

The mining statute sets out mineral royalty collection, due dates, and royalty returns, interacting with the national revenue authority and export controls [1]. In practice, royalty governance also depends on export permits, mineral valuation controls, and inter-agency coordination at exit points, all of which have been repeatedly highlighted as weak in oversight practice [14]. These are also governance-sensitive points in the mining value chain, because weak valuation controls, opaque export procedures, and poor inter-agency coordination can create opportunities for misreporting, revenue leakage, and corruption even where formal royalty rules exist.

Case studies showing where ESG provisions fail in practice

The February 2025 acidic waste spill into the Kafue River

On 18 February 2025, Sino-Metals Leach Zambia's tailings dam failed, releasing large volumes of acidic waste into waterways connected to the Kafue River and causing widespread downstream impacts, including disruption of water supply and ecosystem damage, an archetypal case of catastrophic operational ESG failure [15]. Sino-Metals Leach Zambia is a subsidiary of the state-run China Nonferrous Metal Mining Group. Publicly available reporting at present does not provide a sufficiently clear basis to conclude whether the operator had been fully compliant with all relevant environmental and tailings-management obligations before the failure. What is publicly documented is that investigators linked the incident to a tailings dam collapse, and later reporting raised further questions about the volume of material released, the adequacy of facility design and maintenance oversight, and the transparency of post-incident investigation [15,19].

Follow-on legal and civil-society actions underscore concerns not only about environmental harm, but also about transparency after the incident. Subsequent reporting suggested disputes over the true scale of the release, while a full independent technical account of the causes and long-term contamination footprint was not publicly available at the time of writing. That lack of transparent, authoritative disclosure is itself a governance failure in a major environmental incident [20,21]. The incident also highlights the relevance of the Global Industry Standard on Tailings Management (GISTM), which emphasises consequence classification, robust design, qualified engineering oversight, lifecycle monitoring, accountable governance, emergency preparedness, and public disclosure for tailings facilities [22].

WHY THIS MATTERS FOR ESG ENFORCEMENT:

Zambia's legal framework requires environmental approval before mining and provides restoration, compliance, and audit powers, but a tailings disaster of this scale signals weaknesses in preventive oversight, facility governance, monitoring, and transparency. It also shows why tailings management should be treated not as a narrow technical issue but as a core ESG governance issue aligned with emerging international standards such as the GISTM [22].

Persistent mine safety failures and reactive shutdowns

WHY THIS MATTERS FOR ESG ENFORCEMENT:

the regulator's ability to suspend operations demonstrates formal enforcement capacity; the recurrence of severe incidents indicates that internal safety systems and/or routine oversight and auditing are not preventing failures before they escalate. This also indicates that worker safety should be treated earlier in the brief as a core social and governance issue, rather than only as a downstream enforcement outcome.

Two time-separated but thematically linked safety episodes show both ongoing risk and reactive enforcement. In ESG terms, mine safety should be assessed not only through major incidents and fatalities, but also through routine indicators such as lost-time injuries (LTIs), disabling injury frequency, total recordable injury frequency, near-miss reporting, worker training, contractor management, and the existence of credible internal reporting and whistleblowing mechanisms:

In February 2019, three mineworkers died in an underground fire incident at Mopani Copper Mines' Mindola North Shaft in Kitwe, prompting operational suspension and public reporting about safety failures [23,24].

In February 2026, the Minerals Regulation Commission (MRC) suspended underground operations at Mopani Copper Mines' Mufulira mine after the operator failed to maintain a system capable of accounting for all underground personnel, an explicit breach of safety management requirements, following recent accidents [25,26].

Alleged involuntary resettlement and weak livelihood restoration

WHY THIS MATTERS FOR ESG ENFORCEMENT:

the key issue is not only post-harm compensation, but whether social safeguards are built into development approval and licence management from the outset. If livelihood restoration, land access conditions, consultation, and compensation are not treated as enforceable conditions that can affect licence status (renewal, expansion approvals), social risks shift from "project management" issues into systemic governance liabilities that can provoke legal escalation and operational disruption.

In 2025, farming and fishing communities near First Quantum Minerals' Kansanshi and Sentinel copper mines initiated legal action alleging involuntary resettlement, inadequate compensation, and severe livelihood harm [27].

Earlier documentation of resettlement-related grievances and alleged livelihood restoration failures around major mining developments indicates that these social impacts are not isolated, and that the gap may lie in enforceability, independent verification, and grievance or redress pathways [28].

This also points to a deeper regulatory problem: social protection cannot rely only on compensation after displacement occurs. Preventive safeguards should operate before land access and mine development, including baseline livelihood surveys, independent valuation, meaningful consultation, documented consent procedures where customary land is affected, resettlement action plans, and ex ante verification that replacement land, housing, water access, livelihood restoration, and access to essential services such as healthcare and schools are available, adequate, and enforceable. Where displacement occurs, the objective should be to maintain or improve living conditions rather than merely compensate for loss.

Licensing monitoring collapse for exploration rights

WHY THIS MATTERS FOR ESG ENFORCEMENT:

quarterly reporting is a core monitoring lever; when it collapses in practice and is not sanctioned, regulators lose early-warning signals for environmental risk, social conflict, and speculative hoarding of mineral rights, undermining both governance integrity and supply-chain reliability. More broadly, this is also where business-ethics and security concerns enter the governance dimension of ESG: weak control over licensing, reporting, site activity, and mineral movements can create opportunities for bribery, informal extraction, theft, misreporting, and other integrity failures that are not captured by environmental compliance alone.

A compliance audit of the awarding and monitoring of mining rights (2017 accounts) found that only 12% of exploration right-holders submitted quarterly reports to the Geological Survey function, while 88% did not comply; critically, there was no evidence of punitive measures against the non-compliant right-holders [14]. These quarterly reports are intended to provide the regulator with basic compliance and activity information on exploration progress, helping the state determine whether rights are being actively and lawfully used rather than merely held on paper.

The same audit also documented weak pre-award screening and post-award monitoring. Some right-holders appeared not to be operationally ready because issues such as environmental clearance, consent disputes, or financial constraints remained unresolved after the rights were granted. But the findings may also indicate strategic non-compliance, including speculative acquisition and retention of mineral rights without timely progression to lawful operations. In either case, the result is the same: licensing decisions were not sufficiently tied to verifiable readiness and ongoing compliance [14,29].

These findings indicate the core claim of this brief: Zambia's main challenge is not a legislative vacuum, but a law–practice gap in how existing ESG provisions are operationalised through licensing, monitoring, disclosure, and enforcement. Compliance reporting, environmental conditions, and social safeguards are not consistently embedded into project approval, licence renewal, or publicly visible compliance review. As a result, regulators may lack timely compliance evidence of non-compliance, and preventive oversight becomes reactive rather than anticipatory. A further gap, not yet fully embedded in Zambia's mining oversight architecture, is the treatment of climate-related operational risk. Drought, power shortages, water stress, and extreme rainfall can directly affect extraction, mineral processing, tailings safety, and transport reliability, yet these risks are not consistently translated into enforceable licence conditions or renewal criteria. The policy actions proposed below therefore focus on making ESG obligations operational through licence design and renewal. In practice, this means attaching measurable environmental, safety, community-engagement, and reporting requirements to project approval, annual compliance review, licence renewal, and high-risk facility oversight, while also introducing climate-risk assessment, life-cycle participation rules, and more transparent fiscal governance. Table 1 summarises selected law–practice gaps in Zambia's mining governance system, showing the legal basis for each provision, the intended enforcement mechanism, the observed implementation weakness, and the corresponding reform priority.

Table 1 shows that Zambia's ESG framework provides substantial formal enforcement tools. However, recurring pollution events, safety suspensions, resettlement disputes, and audit findings indicate that monitoring, licence-linkage, and transparency mechanisms remain insufficiently operationalised. These systemic weaknesses justify the targeted reforms outlined below. These reforms differ in timing and legal pathway. Some can be implemented in the short term through licence conditions, regulator guidance, reporting templates, and administrative practice. Others require medium-term regulatory revision or inter-agency protocols. A smaller set, particularly those altering consent rules, revenue allocation, or mandatory closure-related obligations, may require statutory amendment.

PROVISION	LEGAL BASIS	ENFORCEMENT MECHANISM ON PAPER	OBSERVED GAP IN PRACTICE	RECOMMENDED FIX	IMPLEMEN-TATION HORIZON	PRIMARY LEGAL PATHWAY	COMPLEXITY / COST
Mining prohibited without prior environmental approval	Minerals Regulation Commission Act, 2024 (prohibition without EIA approval) [1]	Refusal/ suspension; offence provisions	Severe pollution events and disputes suggest preventive oversight and high-risk facility controls are not consistently effective [15]	Incorporate EIA conditions and tailings-monitoring obligations directly into licence terms; require periodic independent audits for high-risk facilities; and make renewal contingent on documented compliance.	Short term	Administrative / licence condition	Medium
Accident notification and safety management	Minerals Regulation Commission Act, 2024 (accident notification; safety regulation functions) [1]	Inspections, suspensions	Recurrent fatal incidents; suspension triggered by personnel-accounting failures [23]	Require independent safety audits; make safety-system compliance a renewal condition; publish anonymized incident statistics	Short term	Guidance / renewal condition	Medium
Pollution-control licensing and emissions limits	Environmental Management (Licensing) Regulations, 2013 [3]	Licences, emissions limits, returns, sanctions	Where inspections/ returns are weakly enforced, licensing becomes procedural rather than preventive	Require submission and verification of emissions and effluent returns as a condition of licence renewal, supported by digital monitoring and regulator access to key operational data.	Short to medium term	Guidance + digital systems	Medium-High
Environmental audits, inspections, and compliance/ restoration orders	Environmental Management Act, 2011 [2]	Orders + prosecution + audit powers	Performance audit documented weak monitoring/ enforcement outcomes in water pollution control [20]	Publish enforcement register; minimum inspection frequencies for high-risk sites; budget-protected inspectorate staffing	Medium term	Administrative reform + budget	High

TABLE 1. ESG LAW–PRACTICE GAPS IN ZAMBIA'S MINING GOVERNANCE SYSTEM

Policy Implications

The Zambia case indicates that ESG risks in critical mineral supply chains are not isolated project-level concerns but systemic governance gaps. These governance gaps arise not only from weaknesses in state regulation, but also from how mining companies internalise (or fail to internalise) environmental, social, and governance obligations within project design, operational controls, reporting systems, contractor management, and board-level decision-making. Four weaknesses are particularly persistent:

- → ESG principles are often treated as disclosure or reporting exercises rather than enforceable licensing conditions. Where environmental protection, labour standards, and community engagement are not embedded directly into both permitting systems and in company-level management systems, compliance remains inconsistent and reactive.
- → Climate risk remains insufficiently integrated into extraction and processing infrastructure planning. Many mining operations in LMICs are exposed to extreme weather, water scarcity, and energy reliability challenges that can disrupt production and undermine investment stability.
- → Community participation mechanisms are frequently delayed until after project approval, increasing the likelihood of conflict, litigation, and operational disruption. In contexts involving customary land tenure, insufficient recognition of local rights exacerbates governance tensions.
- → Mineral revenue management often lacks transparency and local allocation mechanisms. Without clearly earmarked and independently governed royalty structures, mining revenues may fail to translate into visible local development and environmental rehabilitation outcomes, reinforcing inequality and eroding trust

Policy Recommendations

→

A substantive application of ESG requires enforceable accountability across environmental protection, labour standards, and governance practices. Without binding oversight, ESG risks becoming a reputational exercise rather than a mechanism for structural change.

POLICY ACTION 1:

Embed enforceable ESG requirements within mining and processing licences (short term / regulatory and licence practice)

ESG integration must move from voluntary disclosure to binding regulatory obligation. In many producer countries such as Zambia, ESG remains investor-driven and reporting-based rather than embedded within statutory permitting systems [6,30]. This gap weakens enforcement and allows environmental and social risks to accumulate across the mining life cycle.

Evidence shows that unmanaged environmental and social risks translate directly into operational disruption, project delays, and financial loss, increasing risk for operators, financiers, and host governments [31,32].

Making project-level ESG management plans mandatory and linking annual licence renewal to independently verified ESG performance strengthens accountability across exploration, development, operation, and closure phases.

From a supply security perspective, licensing reform reduces the probability of disruption arising from environmental non-compliance, labour unrest, community opposition, and regulatory intervention.

POLICY ACTION 2:

Require climate risk assessments and adaptation planning across extraction, processing, and transport infrastructure (short to medium term / regulatory guidance and licence conditions)

Zambia's mining and mineral-processing system is already exposed to climate-related disruption through water and energy constraints. The 2023 to 2024 drought reduced hydropower availability and contributed to national electricity shortfalls, increasing operational risk for energy-intensive mining and processing activities and highlighting the need to diversify and strengthen energy resilience in the sector [33]. Climate-related hazards also elevate the consequences of high-risk facilities and corridors, including tailings storage facilities and downstream water infrastructure. For example, the 18 February 2025 Sino Metals tailings dam failure contaminated tributaries of the Kafue system and disrupted water supply and livelihoods, demonstrating the scale of impacts when preventive controls fail [34]. These risks do not end when production slows or ceases: closure, rehabilitation, and post-closure site management are also climate-sensitive phases, especially where tailings, waste rock, acid drainage, and downstream water systems remain vulnerable over long time horizons.

Despite these realities, recent evidence shows that climate-related hazards remain under-integrated in critical mineral supply risk frameworks, even though they are increasingly material to production continuity and investment stability [35]. In Zambia, this gap is also reflected in the broader legal and policy challenge of translating climate considerations into enforceable operational requirements [36].

Governments should therefore mandate forward-looking climate risk assessments and adaptation plans as a standard condition of project approval, major project modification, and periodic licence renewal. These requirements should apply across extraction, processing, tailings facilities, and transport infrastructure, and be updated on a defined cycle to reflect evolving climate projections. At a minimum, assessments should (i) use scenario-based hazard analysis (drought, extreme rainfall, flooding, heat stress), (ii) map exposure and critical dependencies (water supply, power reliability, transport bottlenecks), (iii) evaluate vulnerability of high-consequence assets such as tailings storage and water intake points, (iv) specify adaptation measures that are costed, time-bound, and independently reviewable, and (v) include end-of-life planning for mines, including closure, rehabilitation, post-closure water management, and long-term stability of waste and tailings facilities under changing climate conditions [35].

Embedding climate resilience at the design and renewal stage reduces production volatility, strengthens supply stability, and improves regulatory and investor confidence that mineral development is robust to climate shocks [35].

POLICY ACTION 3:

Mandate inclusive community participation and structured consent-oriented procedures (medium to long term / legal and institutional reform)

Inclusive community participation should be a mandatory condition of project approval, beginning at the earliest stages of exploration and continuing throughout the mine life cycle. In practice, participation often peaks during early approval stages and weakens during construction, operational changes, and resettlement, when grievances and risk exposure tend to intensify. Early consultation reduces the likelihood of conflict escalation, litigation, and operational disruption, which are major sources of project delay and financial loss in the mining sector.

In contexts like Zambia, where mining intersects with customary land tenure, legally recognised participation procedures and structured consent-oriented processes, informed by FPIC principles, should be embedded before licensing and land access decisions are finalised, consistent with international soft-law standards on participation, land-related decision-making, and affected-community rights [37–39]. In this brief, FPIC is proposed not as an unqualified corporate veto-risk concept, but as a structured, documented, and good-faith decision process that must occur early enough to influence outcomes, especially where customary land rights, resettlement risks, or major livelihood effects are at stake. This would extend and formalise protections around customary land governance rather than displace them. Zambia's current mining and environmental framework provides for consultation, but it does not presently establish a general, mining-wide statutory FPIC requirement; accordingly, the proposal advanced here is a reform option rather than a statement of current law. These processes must include structured engagement with traditional authorities and representative community bodies, supported by independent facilitation and culturally appropriate information disclosure to ensure informed decision-making.

Participation should be institutionalised through formal Community Development Agreements (CDA) that clearly specify benefit-sharing arrangements. These may include locally managed development funds, community infrastructure investment, preferential local procurement, and revenue allocation mechanisms. Local employment targets should prioritise host communities and be supported by company-funded vocational training and apprenticeships aligned with project life-cycle needs.

Accessible grievance mechanisms, co-designed with communities and linked to existing dispute-resolution systems, are essential to address emerging concerns early and prevent conflict escalation. Empirical evidence from mining regions in Africa and Latin America shows that structured participation frameworks improve long-term project stability and strengthen social licence to operate.

POLICY ACTION 4:

Establish statutorily earmarked and independently governed mineral revenue funds (medium to long term / statutory and fiscal reform)

Effective fiscal policy is not synonymous with ESG implementation, but it is a critical enabling condition for its success. While ESG obligations operate at the project level through environmental management, labour standards, and community engagement, fiscal governance determines whether mineral revenues translate into long-term development outcomes and reduced economic inequality.

In Zambia and similar mineral-dependent economies, royalty revenues are collected centrally, but weak redistribution mechanisms and limited transparency can prevent mining regions from experiencing visible and sustained development benefits. When local communities perceive that extraction generates national revenue without local returns, social licence deteriorates and conflict risk increases.

Governments should therefore establish statutorily earmarked and independently administered mineral revenue funds that allocate a defined share of royalties to locally visible development, and to public environmental rehabilitation, and mine closure obligations where these are lawfully assigned to public institutions. Such mechanisms should not replace ESG compliance requirements but complement them by ensuring that fiscal flows reinforce social and environmental objectives. The role of government is to create the statutory allocation rules, oversight arrangements, and reporting requirements for these funds. These fiscal mechanisms should serve two distinct purposes. First, they can support benefit-sharing and local development through infrastructure investment, economic diversification, and other visible public goods in mining-affected regions. Second, they can support public environmental rehabilitation and closure-related obligations where the state must manage legacy risks. However, compensation, livelihood restoration, and other reparations for project-specific harm should not be treated as discretionary community-development spending; they should remain enforceable legal obligations of the responsible operator. Governance arrangements should include public financial reporting, independent oversight, structured participation of local government and civil society representatives, and clear rules separating community-development allocations from remedy for operator-caused harm.

By strengthening royalty redistribution and transparency, fiscal reform can reduce regional inequality, improve trust in mining governance, and reinforce the developmental legitimacy of extractive activity. When aligned with enforceable ESG obligations at the licence level, sound fiscal policy becomes a stabilising pillar of resilient mineral supply chains rather than a substitute for regulatory enforcement.

Conclusion

Critical minerals are central to the global energy transition, yet their extraction and processing remain embedded in governance systems that are often institutionally fragile. Without structural reform, mineral expansion risks amplifying environmental degradation, climate vulnerability, social conflict, and revenue misallocation.

These licensing, climate, community, and fiscal reforms strengthen supply chain stability, improve investor confidence, reduce production disruptions, and enhance domestic value capture. Most importantly, they ensure that mineral development contributes to equitable, climate compatible, and institutionally robust growth pathways in low- and middle-income countries.

Securing critical mineral supply for the energy transition therefore requires governance transformation at the project level and at the fiscal level. Operational ESG integration provides the institutional pathway to achieve both.

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CAMBRIDGE CRITICAL MATERIALS LAB

We believe the energy transition must be equitable and inclusive. That means mineral-rich countries and their communities should benefit fully from their resources. By co-creating information platforms, producing rigorous research, and building tools for better decision-making, we work to strengthen equity in how critical materials are used to ensure no one is left behind.

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HOW WE WORK

We combine independent, interdisciplinary research with close collaboration across the Global South to ensure mineral governance is technically sound, socially just, and climate-compatible. By integrating engineering, policy, and social sciences, we create actionable insights that empower governments and communities to defend their rights, advance their interests, and navigate the complex environmental, social, and economic challenges of the energy transition.

OUR TEAM

Blending engineering, policy, and social sciences, our team finds innovative solutions to complex challenges.