
An Investigation of the Economic Sustainability of Environmental Laws in the Mining Sector: A Case Study of Hangu, Khyber Pakhtunkhwa Coal Mines

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Abstract

Natural resource extraction in Khyber Pakhtunkhwa plays a significant role in sustaining the livelihoods of multiple local communities. Still, over-extraction or a non-standardized approach to mining depletes resources for future generations. Thus, it is important to govern the commons through properly defined institutions. However, the sustainability of these institutions and laws remains a question. To address these concerns, qualitative research examines the economic sustainability of environmental laws in the mining sector of Hangu District, Khyber Pakhtunkhwa. The study explores how environmental regulations influence mining operations, local economic development, environmental protection, and community welfare. The study employs a qualitative case study methodology grounded in document analysis and stakeholder interviews. The findings suggest that environmental laws can promote long-term economic sustainability when effectively implemented, although enforcement challenges continue to limit their effectiveness. However, weak administrative approaches also hinder the economic efficiency of mining activities.

Keywords: Environmental Laws, Sustainability, Mining

1.1 Introduction

The environment has become much more important over the years due to the rapid decline in its quality and the need for it by every species on the planet. It has been repeatedly recommended and acknowledged that common ownership involves excessive resource exploitation and that it is wise to reduce use either by imposing government regulations, such as taxes or quotas, or by privatizing the resources to apply excludability (Elinor Ostrom, 1990). Pakistan owns a substantial amount of mineral resources that directly contribute to national economic development. In KPK, Hangu District contains coal and other mineral resources that provide employment and income for local communities. Malkani, M. S., Mahmood, Z., Alyani, M. I., & Siraj, M. (2017). The mining sector plays a vital role in the economic development of Khyber Pakhtunkhwa, Pakistan; however, its long-term viability is increasingly challenged by environmental degradation and inadequate regulatory frameworks. According to the Mining and mineral act 2017 license holder is advised to protect the depletion of natural resources and avoid waste generated during mining activities. Unfortunately, there are no specific rules defined for environmental protection. Mining activities often create environmental concerns, including land degradation, pollution, and health risks. Environmental laws are intended to regulate these impacts while ensuring sustainable economic

growth. Scholars have highlighted significant sustainability concerns within the province's extractive industries, particularly in marble and coal mining operations. A study by Khan et al, (2019) examined the marble sector in Buner and emphasized the need for improved environmental management to achieve economic sustainability. Broader analyses of Pakistan's legal and policy environment reveal persistent gaps in advancing sustainable mining practices. Shah et al. (2026) provided an analytical review of the existing legal framework, arguing that current environmental laws require substantial reform to balance economic growth with ecological protection. Khan and Hussain (2021) further compared Pakistan's environmental policies with those of China, noting deficiencies in enforcement mechanisms that hinder sustainable development. More recent studies have also stressed the importance of integrating economic, social, and environmental dimensions for long-term resource management in the province (Ali & Khan, 2024; Khan & Khan, 2023). Despite these contributions, limited empirical research has focused specifically on the economic sustainability of environmental laws in mining-affected regions. However, as per our research exposure, the authors could not find a single study exploring the economic sustainability of the mining sector in District Hangu, KPK. This study seeks to address this gap by investigating the interplay between environmental legislation and economic outcomes in the mining sector of Hangu, Khyber Pakhtunkhwa.

1.2 Environmental Governance in the Mining Sector

Environmental governance of the mining sector in Pakistan is primarily regulated through provincial environmental legislation, including the Sindh Environmental Protection Act 2014, Punjab Environmental Protection Act 2012, Balochistan Environmental Protection Act 2012, Khyber Pakhtunkhwa Environmental Protection Act 2014, Forest Act 1927, Khyber Pakhtunkhwa Forest Ordinance 2002, and Balochistan Forest Act 2022. These laws are administered by provincial Environmental Protection Agencies (EPAs) and Forest Departments, which are responsible for monitoring compliance and environmental conservation. Before the commencement of any mining project, an Environmental Impact Assessment (EIA) must be submitted to the relevant provincial environmental authority for approval. The review period generally extends up to four months in Sindh, Punjab, and Khyber Pakhtunkhwa, while in Balochistan, the approval process is completed within ninety days. Mining activities in protected or reserved forests are subject to additional requirements, including prior notification to the concerned Forest Officer and compliance with prescribed land-use conditions. Although Pakistan has increasingly embraced sustainability principles, direct incentives for environmentally sustainable mining projects remain limited. The Securities and Exchange Commission of Pakistan (SECP) has introduced the Guidelines on ESG Disclosures for Listed Companies (2023), encouraging transparency and reporting on environmental, social, and governance (ESG) performance. Furthermore, mining lease holders are legally obligated to undertake mine closure and remediation measures, including the filling of excavations, plugging of abandoned mines, removal of infrastructure, and restoration of disturbed land to its original condition. Provincial regulations also require the submission of performance guarantees and financial assurances to ensure compliance with operational and closure obligations. For example, Sindh requires a bank guarantee of Rs. 10,000 per acre, subject to a minimum guarantee of Rs. 30 million. Additionally, mining operators are required to ensure the structural safety of tailings and waste storage facilities, while failure to comply with environmental, rehabilitation, and safety obligations may result in substantial financial penalties. Collectively, these provisions demonstrate Pakistan's regulatory effort to balance mineral resource development with environmental protection, public safety, and long-term sustainability.

This paper evaluates whether environmental regulations contribute to long-term economic sustainability in the mining sector of Hangu. To examine the role of environmental laws in regulating mining activities in Hangu and to assess the economic implications of environmental compliance. The case of Hangu provides an opportunity to assess the effectiveness of environmental regulation in balancing economic benefits and environmental protection. This study will contribute to the existing body of knowledge by providing

possible answers to the following questions under consideration.

- a) How do environmental laws affect the economic sustainability of mining activities in Hangu?
- b) What are the major implementation challenges, and how do stakeholders perceive the effectiveness of environmental regulations?

1.3 Mining in Hangu, Khyber Pakhtunkhwa, KPK

The Khyber Pakhtunkhwa Mines and Minerals Act, 2017, along with its subsequent amendments in 2019, introduced a structured regulatory framework for mineral development and environmental management in the province. The Act establishes buffer zones for mining activities by prohibiting operations within 300 meters of public infrastructure and human settlements in rural areas and 500 meters in urban areas unless special permission is granted. Revenue generation from mining activities is primarily based on royalty calculations, which are determined according to the quantity and type of mineral extracted. The provincial government also sets district-wise production and development targets to enhance mineral sector performance and resource utilization. The legislation differentiates between small-scale and large-scale mining operations and requires operators to obtain the appropriate permits and leases before commencing extraction activities. In addition to economic obligations, mining companies are expected to contribute to local development through Corporate Social Responsibility (CSR) initiatives that support affected communities. Under the original 2017 Act, a prospecting license could be granted for a period of two years, while mining leases were generally issued for ten years. However, the 2019 amendments significantly expanded these timeframes by extending prospecting licenses to five years and mining leases to thirty years. These changes were introduced to encourage long-term investment, improve resource planning, enhance regulatory compliance, and promote sustainable mineral development within the province.

2.1 Theoretical Foundations of Environmental Laws and Economic Sustainability

The relationship between environmental protection and economic development has been a central concern in environmental economics and policy studies. Traditionally, environmental regulations were viewed as constraints on economic growth because they imposed additional costs on businesses and industries. However, modern theories suggest that well-designed environmental laws can promote sustainable economic development by encouraging innovation, resource efficiency, and long-term environmental stewardship.

One of the most influential contributions to this debate is Romer's (1990) theory of endogenous growth. Romer argued that economic growth is driven by technological innovation and knowledge creation rather than solely by the accumulation of capital and labor. His work provides a theoretical basis for environmental regulations that encourage firms to adopt cleaner technologies and innovative production methods. From this perspective, environmental laws can contribute to economic sustainability by stimulating technological progress and improving resource efficiency (Romer, 1990).

Similarly, Ostrom (1990) challenged conventional assumptions regarding the management of common-pool resources. Through her analysis of resource governance systems, she demonstrated that communities can successfully manage shared environmental resources through collective action and locally developed institutions. Ostrom's work is particularly relevant to mining regions where natural resources, water systems, and environmental assets are shared among multiple stakeholders. Effective governance mechanisms can therefore contribute to both environmental conservation and economic sustainability (Ostrom, 1990).

The economic dimensions of environmental regulation were further developed by Nordhaus (1994), who emphasized that environmental degradation imposes significant economic costs on society. His work on climate economics demonstrated that environmental regulations can improve social welfare by reducing long-term environmental damages. Environmental policies, therefore, should not be viewed solely as

regulatory burdens but as investments that prevent future economic losses associated with pollution and resource depletion (Nordhaus, 1994).

Costanza (1996) expanded this perspective by emphasizing the economic value of ecosystem services. According to Costanza, environmental resources provide essential services such as water purification, climate regulation, and biodiversity conservation, which contribute significantly to economic welfare. Environmental degradation undermines these services and creates hidden economic costs. Consequently, environmental laws play an important role in preserving natural capital and ensuring sustainable development (Costanza, 1996).

2.2 Economic Analysis of Environmental Law

The economic analysis of environmental law provides a framework for assessing whether environmental regulations generate benefits that outweigh their implementation costs. This approach evaluates environmental legislation based on efficiency, effectiveness, and its contribution to social welfare.

Faure (2001) argued that environmental regulations should be assessed through cost-benefit analysis. According to this perspective, environmental laws are economically justified when the benefits of pollution reduction and environmental protection exceed compliance and enforcement costs. The objective of environmental law should therefore be to achieve an optimal balance between environmental quality and economic productivity.

Ashford and Caldart (2008) further argued that environmental regulation should not be viewed as an obstacle to economic growth. Instead, they suggested that stringent environmental standards can stimulate technological innovation, improve industrial efficiency, and create new economic opportunities. Their work supports the notion that environmental protection and economic development can be mutually reinforcing objectives.

Similarly, Cline (2010) emphasized the importance of incorporating long-term environmental costs into economic decision-making. Environmental degradation often produces impacts that are not immediately reflected in market prices, resulting in market failures. Environmental regulations can correct these failures by ensuring that polluters bear the costs of environmental damage. This principle, commonly known as the "polluter pays principle," remains a cornerstone of modern environmental law and policy. These studies collectively suggest that environmental regulations should be evaluated not only in terms of immediate compliance costs but also in relation to their long-term economic benefits. Such an approach is particularly relevant for the mining sector, where environmental impacts may persist long after mining operations have ceased.

2.3 Environmental Policies and Sustainable Development

The concept of sustainable development has become a guiding principle for environmental policymaking worldwide. Sustainable development seeks to balance economic growth, social welfare, and environmental protection to ensure that present needs are met without compromising the ability of future generations to meet their own needs.

Recent studies have emphasized the importance of environmental policies in achieving sustainable development goals. Adanma and Ogunbiyi (2024) conducted a comparative review of global environmental policies and found that effective environmental regulations can support economic growth while simultaneously promoting environmental sustainability. Their findings challenge the traditional view that economic development and environmental protection are inherently conflicting objectives.

Likewise, Khater et al. (2025) examined legal frameworks designed to balance environmental conservation with economic development. Although their study focused on tourism, the broader implications are applicable to other natural resource sectors, including mining. The authors concluded that effective legal frameworks can facilitate economic growth while ensuring the sustainable management of environmental

resources. These studies indicate that environmental laws can serve as instruments for sustainable development when they are supported by effective governance structures and implementation mechanisms. This perspective is particularly relevant for countries seeking to balance resource extraction with environmental protection.

2.4 Environmental Laws and Sustainable Development in Pakistan

Pakistan has experienced increasing environmental challenges associated with rapid population growth, industrialization, urbanization, and resource extraction. In response, the country has developed a range of environmental policies and legislative frameworks aimed at promoting sustainable development.

Hassan, Afridi, and Khan (2019) examined Pakistan's energy policies and environmental security using a multi-criteria analytical framework. Their study highlighted the complex relationship between energy production, economic development, and environmental sustainability. The authors argued that effective environmental governance is essential for ensuring long-term energy security and sustainable economic growth.

Muhammad, Muhammad, and Hussain (2025) reviewed Pakistan's environmental laws and policies and identified several implementation challenges. While Pakistan possesses an extensive legal framework for environmental protection, enforcement remains inconsistent due to institutional limitations, resource constraints, and governance challenges. These findings suggest that the effectiveness of environmental laws depends not only on their design but also on their practical implementation.

Further evidence is provided by Salman and Wang (2025), who investigated the impact of Pakistan's national environmental policy on green economic development. Their findings indicate that environmental policies can contribute positively to sustainable economic growth by encouraging environmentally responsible economic activities and improving environmental performance. This study provides empirical support for the argument that environmental regulation can generate economic as well as environmental benefits.

Together, these studies demonstrate that environmental laws play an increasingly important role in Pakistan's development agenda. However, significant questions remain regarding their effectiveness within specific economic sectors, particularly the mining industry.

2.5 Mining Resources and Economic Development in Khyber Pakhtunkhwa

The mining sector represents an important component of Pakistan's economy, particularly in mineral-rich regions such as Khyber Pakhtunkhwa (KP). The province contains substantial reserves of coal, marble, limestone, gypsum, and other economically valuable minerals. Malkani et al. (2017) documented the distribution of mineral deposits across Khyber Pakhtunkhwa and the former Federally Administered Tribal Areas (FATA). Their study highlighted the significant economic potential of the province's mineral resources and emphasized the importance of mining activities for regional development and employment generation.

Coal remains one of the most important mineral resources in the province. Khan et al. (2022) investigated coal occurrence and quality in western Khyber Pakhtunkhwa using geophysical techniques. Their findings confirmed the presence of substantial coal reserves capable of contributing to regional energy production and economic growth. However, the study also highlighted the need for responsible resource management to ensure long-term sustainability. The broader relationship between resource utilization and development has also been explored by Khan et al. (2025), who emphasized the importance of inclusive and sustainable development processes within Pakistan's economy. Their work suggests that resource extraction should contribute not only to economic growth but also to social welfare and environmental sustainability.

These studies underscore the economic importance of mining activities in Khyber Pakhtunkhwa while simultaneously highlighting the need for effective environmental governance.

2.6 Environmental Laws and Economic Sustainability in the Mining Sector

Mining operations generate significant environmental impacts, including land degradation, air pollution, water contamination, biodiversity loss, and greenhouse gas emissions. Environmental laws seek to minimize these impacts through regulatory requirements related to environmental assessments, waste management, pollution control, and mine rehabilitation.

The theoretical and empirical literature reviewed above suggests that environmental regulations can contribute to economic sustainability by reducing environmental damage, protecting ecosystem services, improving public health, and encouraging technological innovation. However, compliance with environmental regulations may also increase operational costs for mining companies, particularly in developing countries where technological and financial resources may be limited. The central debate within the literature concerns whether the long-term benefits of environmental protection outweigh the short-term costs of compliance. While environmental economists generally argue that environmental regulations generate net social benefits, evidence from developing countries remains limited, particularly at the sectoral and regional levels. Consequently, there is a need for empirical studies that assess the economic sustainability of environmental laws within specific mining contexts.

The reviewed literature provides substantial theoretical and empirical evidence regarding environmental economics, environmental law, sustainable development, and resource governance. Foundational studies by Romer (1990), Ostrom (1990), Nordhaus (1994), Costanza (1996), Faure (2001), and Ashford and Caldwell (2008) establish that environmental regulations can contribute to long-term economic sustainability through innovation, efficient resource management, and environmental protection. At the national level, studies have examined Pakistan's environmental policies, legal frameworks, and sustainable development initiatives. Similarly, research in Khyber Pakhtunkhwa has focused on mineral resources, coal deposits, and regional economic development. However, there remains a significant gap in the literature concerning the economic sustainability of environmental laws within the mining sector.

Specifically, existing studies have not comprehensively examined how environmental regulations affect the economic viability of coal mining operations in Hangu District. Limited attention has been given to the relationship between environmental compliance costs, environmental protection outcomes, and long-term economic sustainability. Furthermore, stakeholder perceptions regarding the effectiveness and economic implications of environmental laws in the Hangu coal mining sector remain largely unexplored. Therefore, this study seeks to address this gap by investigating the economic sustainability of environmental laws in the coal mines of Hangu, Khyber Pakhtunkhwa, thereby contributing to both environmental governance and mining sustainability literature.

3.0 Data and Methodology

This study adopts a qualitative case study design. Data sources include environmental legislation, policy documents, government reports, academic literature, and stakeholder perspectives reported in public documents. A thematic analysis approach is used to identify recurring themes relating to economic sustainability, environmental compliance, governance, and community welfare. The case study analysis focuses specifically on mining activities within Hangu District. The authors conducted 9 Unstructured interviews with stakeholders to understand the compliance status and how environmental laws are supporting or hindering the economic effectiveness of mining in Hangu.

4.0 Results, Findings, and Discussion

The Environmental Protection Agency (EPA), wildlife protection, and forest departments are directly influencing mining operations and the associated costs of mining activities. As per the 2017 and 2019 mining and mineral act documents, mining operations should avoid waste and encroachments and are also advised to protect forests and prevent natural resource depletion. The analysis indicates that environmental

laws provide an important framework for responsible mining practices. Environmental impact assessment requirements and regulatory monitoring encourage mining firms to consider environmental consequences. However, implementation gaps remain due to limited resources, institutional constraints, Dishonesty, and weak monitoring mechanisms. Environmental compliance costs may increase short-term operational expenditures, but they also reduce environmental degradation and future remediation costs. Sustainable mining practices contribute to long-term economic stability by protecting natural resources and community health, thus leading to higher net social gains. Out of nine interviews, 3 are mining contractors, 2 are mining Assistant directors, and 4 are owners of mines in different locations. This sample is a good representative of only the district of Hangu coal mines.

4.1 Major Findings

Most of the respondents believe that Government regulations require mining operators to conduct environmental impact assessments through a third party, obtain the environmental approvals, maintain monitoring systems, compensate affected landowners, and implement rehabilitation measures. These requirements increase operational expenditures for mine operators. However, environmental compliance reduces future liabilities associated with land degradation, water contamination, community conflicts, and regulatory penalties. This is apparent from the data of this research. Most coal mine owners and contractors agreed to the statement that environmental compliance increases net social gains in the long run. Consequently, environmental laws contribute to long-term economic sustainability despite increasing short-term production costs. According to an Assistant Director of Mining and Minerals, Environmental laws require compensation for land use, protection of public infrastructure, and restrictions on mining activities near settlements and environmentally sensitive areas. In Hangu, where coal mining operations occur in proximity to local communities, these provisions help reduce disputes between mining operators and residents. Most of the mining locations are up to the mark, but a few are controversial. Owners consider that improvement in the community relationships with stakeholders can contribute to continuous production, lower conflict-related costs, and enhanced long-term economic viability of mining operations. Taking care of people resources reduces conflicts, increases trust, and reduces extra costs. Sarozai is a village where representatives from locals have negotiated on each of the above aspects of mining and resulted in net social benefits.

Although Khyber Pakhtunkhwa possesses a comprehensive legal framework governing mining and environmental protection, implementation challenges remain significant. Government reports and sectoral assessments frequently highlight limitations in monitoring capacity, environmental inspections, technical expertise, and institutional coordination. As a result, environmental degradation may continue despite the existence of regulatory requirements, reducing the overall economic efficiency of environmental governance. Mining and Acts 2017 has clearly mentioned that mining contractors are to comply with environmental protection during mining activities. Environmental regulations governing land restoration, forest protection, water resources, and mine closure are designed to conserve natural capital. Since the implementation is the main issue, in coal mining regions such as Hangu, environmental degradation can reduce agricultural productivity, damage water resources, and limit future economic development opportunities. There is a negotiation culture, where compliance cost is compared to negotiation cost, and it remains a theoretical statement that the environmental laws therefore contribute to economic sustainability by safeguarding ecosystem services that support local livelihoods beyond the life of the mine. The views of all the stakeholders are aligned on this point, but unfortunately, some deep state variables are also influencing factors in the mining sector, which may not be tracked effectively for policy inputs. Talking to an AD on reforms has highlighted the amendments to the Khyber Pakhtunkhwa Mines and Minerals Act 2017, which extended mining lease periods from ten years to thirty years and prospecting licences from two years to five years in 2019. Longer lease durations provide investors with greater security and encourage

investment in environmental management, modern mining technologies, and mine planning. This regulatory approach supports economic sustainability by aligning long-term profitability with environmental stewardship and responsible resource utilization. It actually helps investors to reach economies of scale, where they can benefit from the projects.

4.2 Findings from Stakeholders in Hangu Coal Mines

Most respondents acknowledged the importance of environmental protection and agreed that mining activities can undesirably affect land, water resources, vegetation, and local communities. However, mine owners and contractors reported that compliance with environmental regulations, including environmental assessments, land compensation, safety measures, and rehabilitation requirements, increases operational costs and reduces profit margins, particularly for small-scale operators, and most of the running projects are small-scale. Assistant Directors and contractors indicated that environmental regulations are not uniformly enforced across all mining operations. Participants noted that some operators invest in environmental compliance while others continue operations with limited oversight. This uneven implementation creates perceptions of unfair competition and reduces incentives for responsible mining practices. A majority of stakeholders believed that environmental regulations are necessary for ensuring the long-term viability of the mining sector. Respondents emphasized that uncontrolled mining can result in land degradation, community opposition, and resource depletion, which eventually impede the future of coal extraction activities in Hangu. Environmental management was therefore viewed as an investment in long-term sector sustainability rather than merely a regulatory obligation.

Mine owners and government representatives described that disagreements with local communities are reduced when workers meet the terms of environmental requirements and provide timely compensation for land use and environmental disturbances. Stakeholders highlighted that effective environmental management contributes to social acceptance, uninterrupted mining activities, and reduced conflict-related costs. Government officials and mining operators identified shortages of technical expertise, environmental monitoring equipment, and institutional resources as major barriers to effective environmental governance. Several respondents suggested that stronger coordination between the Mines and Minerals Department, Environmental Protection Agency, and local administration would improve compliance and promote sustainable mining practices in the district. Many stakeholders noted that the extension of lease periods under recent legislative reforms has improved investor confidence. Respondents argued that longer lease durations make it economically feasible to invest in environmental protection measures, infrastructure improvements, and mine planning because operators can recover these costs over an extended period. Across all stakeholder groups, there was a common perception that environmental laws should protect natural resources without imposing unnecessary regulatory burdens on mining enterprises. Respondents generally supported a balanced approach in which environmental protection, economic profitability, employment generation, and community welfare are pursued simultaneously.

5.0 Conclusion

This study investigated the economic sustainability of environmental laws in the mining sector through a case study of coal mines in Hangu District, Khyber Pakhtunkhwa. The findings indicate that environmental laws play a critical role in promoting sustainable mining practices by regulating environmental impacts, protecting community interests, and ensuring the responsible utilization of mineral resources. The Khyber Pakhtunkhwa Mines and Minerals Act, 2017, together with environmental protection legislation, establishes a regulatory framework that seeks to balance economic development with environmental conservation. The study found that environmental regulations impose additional compliance costs on mining operators through environmental assessments, compensation mechanisms, monitoring requirements, and rehabilitation obligations. These costs are often viewed by mine owners and contractors as financial burdens, particularly

for small-scale mining operations. However, both documentary evidence and stakeholder perceptions suggest that environmental laws generate significant long-term economic benefits by reducing environmental degradation, minimizing conflicts with local communities, protecting ecosystem services, and lowering future environmental liabilities.

The findings further reveal that environmental protection contributes to the sustainability of mining operations by enhancing community acceptance, improving resource management, and supporting long-term investment planning. The extension of mining lease periods under the 2019 amendments has increased investor confidence and created opportunities for greater investment in environmental management and operational efficiency.

Despite the existence of a comprehensive legal framework, challenges remain regarding enforcement effectiveness, institutional coordination, environmental monitoring capacity, and technical support for mining operators. Weak implementation and inconsistent compliance reduce the effectiveness of environmental regulations and limit their contribution to sustainable development. Therefore, the economic sustainability of environmental laws depends not only on the legal provisions themselves but also on the effectiveness of their implementation and enforcement.

Overall, the study concludes that environmental laws in the Hangu coal mining sector are economically sustainable when evaluated from a long-term perspective. While compliance generates short-term operational costs, the environmental, social, and economic benefits associated with responsible mining practices outweigh these costs and contribute to sustainable regional development.

5.2 Policy Recommendations

The Government of Khyber Pakhtunkhwa should strengthen environmental monitoring systems by increasing the capacity of the Environmental Protection Agency and Mines and Minerals Department. Regular inspections, environmental audits, and compliance assessments should be conducted to ensure that environmental laws are implemented uniformly across all mining operations. A specialized environmental management unit should be established within the Mines and Minerals Department to coordinate environmental compliance, mine rehabilitation, environmental reporting, and stakeholder engagement. This would improve institutional coordination between the EPA, Forest Department, and mining authorities.

The government should provide incentives for mining companies that demonstrate high environmental performance. These incentives may include reduced permit fees, tax benefits, expedited approvals, or recognition programs for environmentally responsible operators. Such measures would encourage voluntary compliance and promote sustainable mining practices. Mining operators should be required to prepare comprehensive mine closure and rehabilitation plans at the beginning of mining operations. Financial assurance mechanisms, including environmental bonds and rehabilitation funds, should be strengthened to ensure that sufficient resources are available for post-mining restoration activities.

Local communities should be actively involved in environmental decision-making processes through public consultations, grievance mechanisms, and representation in district-level mining committees. Community participation can improve transparency, reduce conflicts, and strengthen social acceptance of mining projects. Training programs should be developed for mine owners, contractors, and workers on environmental management, pollution control, waste management, occupational safety, and sustainable mining practices. Capacity building can improve compliance while reducing environmental risks and operational inefficiencies. The government should encourage the use of modern and environmentally friendly mining technologies through financial support, technical assistance, and technology transfer initiatives. Cleaner technologies can reduce environmental impacts while improving productivity and resource efficiency.

A centralized environmental information system should be established to collect and monitor data on air quality, water quality, land degradation, mine rehabilitation, and environmental compliance. Reliable data

will support evidence-based policymaking and improve environmental governance. Mining companies should be encouraged to invest in local development initiatives, including education, healthcare, water supply, infrastructure development, and environmental conservation programs. CSR activities can enhance community welfare and contribute to sustainable regional development. The provincial government should formulate a comprehensive sustainable mining policy that integrates economic growth, environmental protection, climate resilience, community welfare, and resource conservation. Such a policy would provide a long-term strategic framework for sustainable mineral development in the province.

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