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Mine Closure Strategies and Concerns in India:

A Review on Practices and Strategies

The closure of mines in an environmentally sustainable manner is a matter of concern throughout the country. The overarching principle of mine closure is also reflected in the United Nation's Sustainable Development Goals (SDGs), which was adopted in 2015. In India, mineral resource extraction has been laden with a bequest of large areas of unplanned mine closures and unreclaimed and derelict lands. Mining operations in recent past were being carried out with deficient methods and irresponsible practices without regard to environmental protection. Such activities thus have resulted in irreversible degradation and impairment of natural ecosystems of the mined over areas and in the vicinity. The review paper attempts to provide an overview of various practices followed for mining closure in India highlighting global parallels. The review highlights international and Indian practices and concerns regarding environmentally prudent sustainable mining closure strategies and attempts to identify (or look at) the gaps. It is revealed that the planning of mining and mine closure and rehabilitation and the operational practices thereof are deficient in internalizing the fundamental concept of optimizing the post-mining land-use and its integration in the mine plan at the inception of the mining project, and commencement of mining activities. To minimise the possible long-term detrimental effects on the environment, the mine planning needs to be formulated with a thrust on ensuring the optimal sustainability of the ecosystem after the mine closure over the long term and regulated with an efficient tracking and monitoring system throughout – during mining phase and the mine closure phase.

Key words: Mining Plan, Mine closure plan, Sustainable development, Mining industry, Reclamation**,** Eco restoration

It's high time to recompense the lands burdened with the undesirable legacy of abandoned unreclaimed or poorly rehabilitated mining lands with the best feasible restoration and well planned mine closures.

Introduction

The mining industries globally face the challenge of supporting an ever-increasing demand for raw materials while protecting the natural and social environments (Manero *et al.,* 2020). It is further stipulated that the mining companies and operators should be obliged to clean up their sites to a state that supports the agreed post-mining land use to mitigate environmental and social impacts. Mining operations are usually short-term and are finite economic activities in the context of land use and environmental and ecological concerns. The project site's long-term ecological and social performance is anticipated once the mining operations cease. Ineffective enforcement of mine reclamation policies, an absence of financial mechanisms, and inadequate financial assurances can significantly impact the success of mine site closure and completion (Peck, 2005), and post-mining utility and values – instrumental as well as intrinsic. The environmental sustainability of mining operations and the closures of mining are serious concern around the globe. In India, stringent regulations have been introduced over the last few decades, to handle environmental concerns with increasing environmental standards in every revision. However, ensuring the best feasible mining closure as the essential and actual process of sustainable mining continues to be in the deficit and a challenge. Unsustainable and environmentally deficient or

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non-conforming mining operations and practices during the main mining phases and/or during the final closure phases of mining lead to severe detrimental impacts on the environment. The mismanaged operations and deficient practices adversely affect the environment in many ways, including contaminating surface water, groundwater, unstable tailings leading to acid rock drainage, and dangerous open pits. The scope of the potential rehabilitation of the mined over areas is also diminished and the end result is degraded and derelict lands rendered permanently poor in ecological functions and services. Such areas also depress the overall ecosystem health of the vicinity zones of direct impact.

In India, resource extraction and use have been hindered by unplanned mine closures and unreclaimed lands. Mining companies with irresponsible mining methods without regard for environmental protection and mine rehabilitation lead to irreversible natural damage. Moreover, less effective mine closure policies, legislative controls, and lack of vision in mine closure plans have resulted in more abandoned and derelict mine sites with damaged or very degraded environmental and ecological status. The Indian mining industry is characterized by a large number of small operational mines. Reporting mine is defined as “A mine reporting production or reporting 'nil' production during a year but engaged in developmental work, such as overburden removal, underground driving, winding, sinking work, exploration by pitting, trenching or drilling as evident from the Mineral Conservation and Development Rules returns”. Such sites substantially impact environmental liabilities and mine rehabilitation costs without appropriate legislative frameworks and controls.

For the country's current development imperatives, the mining sector is on the rise in India, and there is a need to strengthen policies and practices for sustainable mining with integrated environmentally and ecologically sound mine closure plans. At the inception of mining, a well-conceived and planned mine closure plan is still at an early stage of development in India, with very few examples of mine closure planning applied from conception to completion of mining operations. The mining industry and relevant government organizations have been deficient in developing comprehensive best-practice standards, regulating and controlling mine closure planning and completion. The current gaps in mine closure planning and mining legislation illustrate the need for an integrated approach to mine closure plans with improved mining legislation and closure requirements. Legislation and mine closure requirements must incorporate the social, environmental, and economic considerations within the overall duration of mine site operations, closure, and completion practices.

The overarching necessity for environmentally sustainable mining together with the mine closure is also reflected in the UN's Sustainable Development Goals (SDGs), in 2015. SDG 8 promotes sustained, inclusive, and sustainable economic growth, full, productive employment, and decent work for all; and SDG 12 ensures sustainable consumption and production patterns (United Nations Development Programme, 2015). These two goals align with the guiding principles for restoring the mined-out land to a self-sustaining ecosystem for the benefit of the local communities. The mine closure is not a one-off stage, process and activity that manifests only after mining is finished, commences thereafter, and ends when the mine is reclaimed and restored following the approved mine closure plan. Instead, it is a composite and continuous process spanning the entire life of the mining activity. Its broad outline is implicated at the time of the mine planning and designing and the end state is factored by the actual mining operations progression and reclamation and restoration processes. Therefore, the underlying theme of mine closure is required to promote sustainable development in terms of the final or end status of the mining lands transformed with reclamation, rehabilitation and restoration and returned to different post-mining land use. Various approaches are being followed in the mining sector to conduct mining closures. Although national and international guidelines on mine rehabilitation and closure exists, there is still a lack of guidance on defining achievable and measurable criteria that reflect rehabilitation success (Iipinge *et al.*, 2021).

The objective of the review paper is to provide an overview of mining status in India with repect to its distribution and statistics related to mining closure plans in the past decade. Further, the study aims to review various mining closure practices being followed worldwide. It aims to highlight global and Indian practices and concerns regarding sustainable mining closure plan strategies and attempts to appraise and address the gaps.

Methodology

To understand the distribution and statistics related to mining closure plans in India in the past decade, reports and academic papers related to the mining closure plan strategies during the past decade (2010-2022) were selected using Googles Scholar and the publisher's website. The keywords used to determine the relevant content were Mining closure plans, Strategies of mining closure and Mining closure plans in India. In addition, related government websites included the present status of the mining closure plan in the study. Finally, the relevant articles published worldwide were selected, which provided information about the existing closure plans.

An overview of mining closure plan

Global approach

Good mine closure and relinquishment is one whereby closure planning is done during the entire mine cycle of a mining operation (Everingham *et al.*, 2020). The International Council on Mining and Metals (ICMM)

Fig. 1: Risk management key Process as per International Organisation for Standardization (2018) (Source : ICMM, 2019a)

brings a closure mining plan to strengthen environmental and social performance and enhance mining's contribution to society. The closure guide intended to promote a disciplined approach to integrated closure planning and increase the uniformity of good practice across the sector. A pathway (Fig. 2) that is aligned with the organization of the closure guide can be drawn through the key elements of mine closure (Brock, 2021). In a case study of South Africa, it was observed in a large open pit hard rock mining operation that a digital terrain model (DTM) could significantly improve closure cost estimates. For this, the Integrated Closure Planning System (ICPS) was developed and used by a British-based multinational mining company (Anglo American plc) to combine the various mine planning regimes, including internal and external requirements, financial considerations, and systems from people, process, and technology perspective (Kumari and Cooper, 2019).

The study of the mining closure plan in the Philippines suggested that mine closure planning must be integrated within the overall mine operations plan and should be integral to the operational life cycle of the mine. This integration will allow mining operations to identify future constraints and costs of mine closure along with financial provisions and assurances. Such integration will also lead to stakeholder engagement and community consultation within the overall mine operations and closure processes. Such practice will provide clear and measurable indicators required to track compliance (Amelia, 2018). In Namibia, a study by Iipinge *et al.* (2021) explicitly refers that rehabilitation should not be just a requirement, but there should be specific regulations, authorized agencies, or sufficient resources to implement these rehabilitations.

An Indonesian study highlighted that the closure plan should ensure stable and safe conditions to protect public safety and health (Suhartoyo *et al.*, 2021). The mining area left remaining after the mining operation should not deteriorate the environment with unacceptable toxic discharges. It suggested that the residual (or left-over) infrastructure should be socially sustainable, and future liabilities should be minimized for all stakeholders. The mining closure plan depends on the key aspects that involve stakeholder consultation,

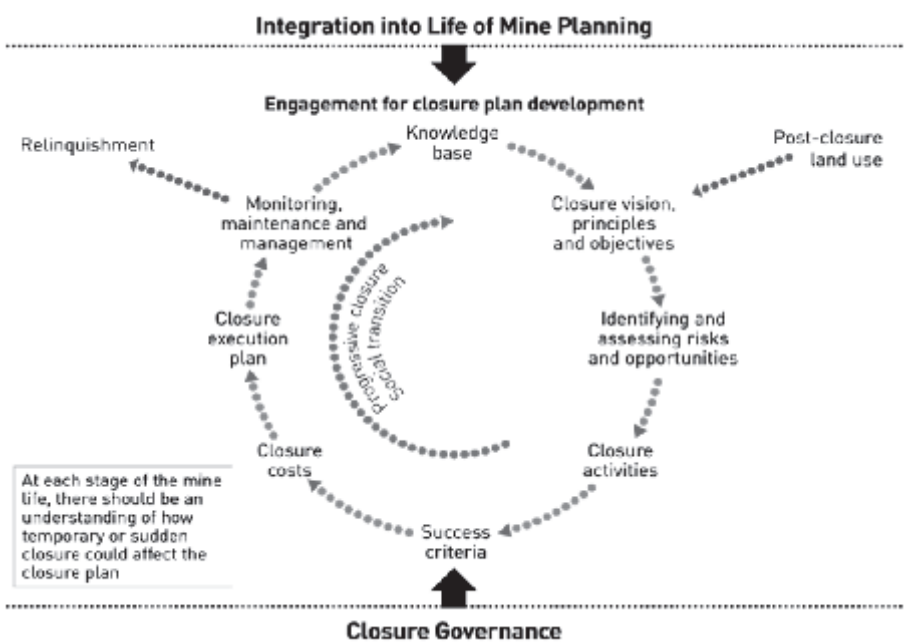

Fig. 2: Key elements of mine planning and implementation (Source : ICMM, 2019a)

better planning, financial provision, ensuring implementation according to standards criteria, and responsible authority (Suhartoyo *et al.*, 2021).

A study in Ghana applied the Preference Ranking Organisation Method for Enrichment Evaluation (PROMETHEE) to decide on the optimal choice of post-mining land use for the closure planning process. The mining closure plan by Starke (2008) was adopted (Fig. 3). It suggested to begin planning during the project feasibility assessment phase and concluding it with the surrender of tenure. The multi-criteria parameters were used to plan mining closure (Fig. 4) and suggested that the earliest possible time to plan for closure is at exploration, although the exploration phase may not necessarily result in an operating mine (Eshun *et al.*, 2018).

In a study in South Africa, a critical point of emphasis was the extent to which transparency of outcomes depends. This often-overlooked feature explains the dynamics between the suppliers and consumers of reporting information. It was emphasized in the study that mine closure provides a robust case, but it is suggested that since it is a complex social and technical process, there is a need for a publicly available scholarship. Such initiatives will enhance awareness about the issues as the underlying base information and will strengthen the transparency cycle (Crous *et al.*, 2020).

In Quebec, Canada, a study emphasized that existing regulations include managing closure by community engagement processes rather than solely depending on environmental and social impact assessments. However, such a process leads to a lack of adequate social planning and community input. Therefore, Monosky and Keeling (2021) suggested strengthening regional authority over closure planning to improve the outcomes.

The European Institute of Innovation and Technology on Raw Materials (EIT RM) created a new digital system for managing the mine closure process under the closurematic project (2018-2021). The researchers suggest that such a versatile tool might help mining companies and consultants to plan, manage, monitor, and document mine closure at every step of a mining project. The main functions include an easily adaptable master plan (using tailored templates), links to the best international practices, and a geographic information system (GIS) interface (Kauppila *et al.*, 2019).

A study in Brazil suggested applying well-established Management Operating Systems (MOS) to the discipline of closure planning, which should not be overlooked during the operational management decision-making process. Integration of mine closure planning should be integrated into MOS to maintain the industry's sustainability (Lacy *et al.*, 2019).

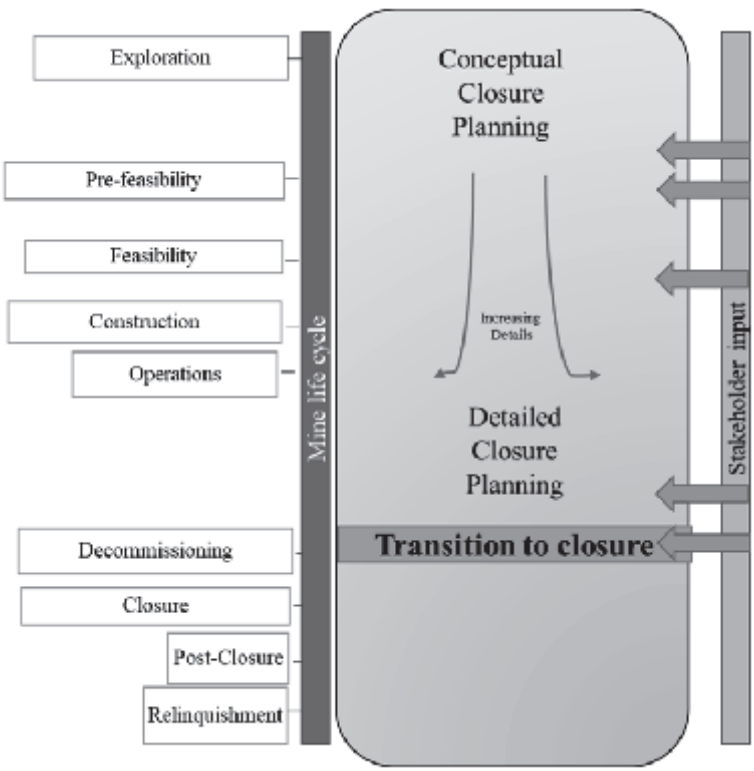

Fig. 3: Mine Closure Planning Process (Source : Strake, 2008)

In Małopolska, Poland, the post-mining regions reclamation system was developed based on fuzzy logic for supporting the decision regarding the closure plan. However, it provided a rational approach in the case of selecting the direction of reclamation of the open-pit mining gravel and sand aggregate mining plant (Korczak and Brzychczy, 2019). The fuzzy logic-based supporting system has an advantage over other methods. This approach considers multiple parameters and provides possibilities to explore their interrelationship. In Brazil, taking an ecosystem services approach to explain and explore the mine closure planning process with both the community and the mining company alike provided a pathway for agreeing to post-mining land use as the approach's inherent anthropic focus provides a way to include community perspectives. Rosa *et al.* (2018 a & b)

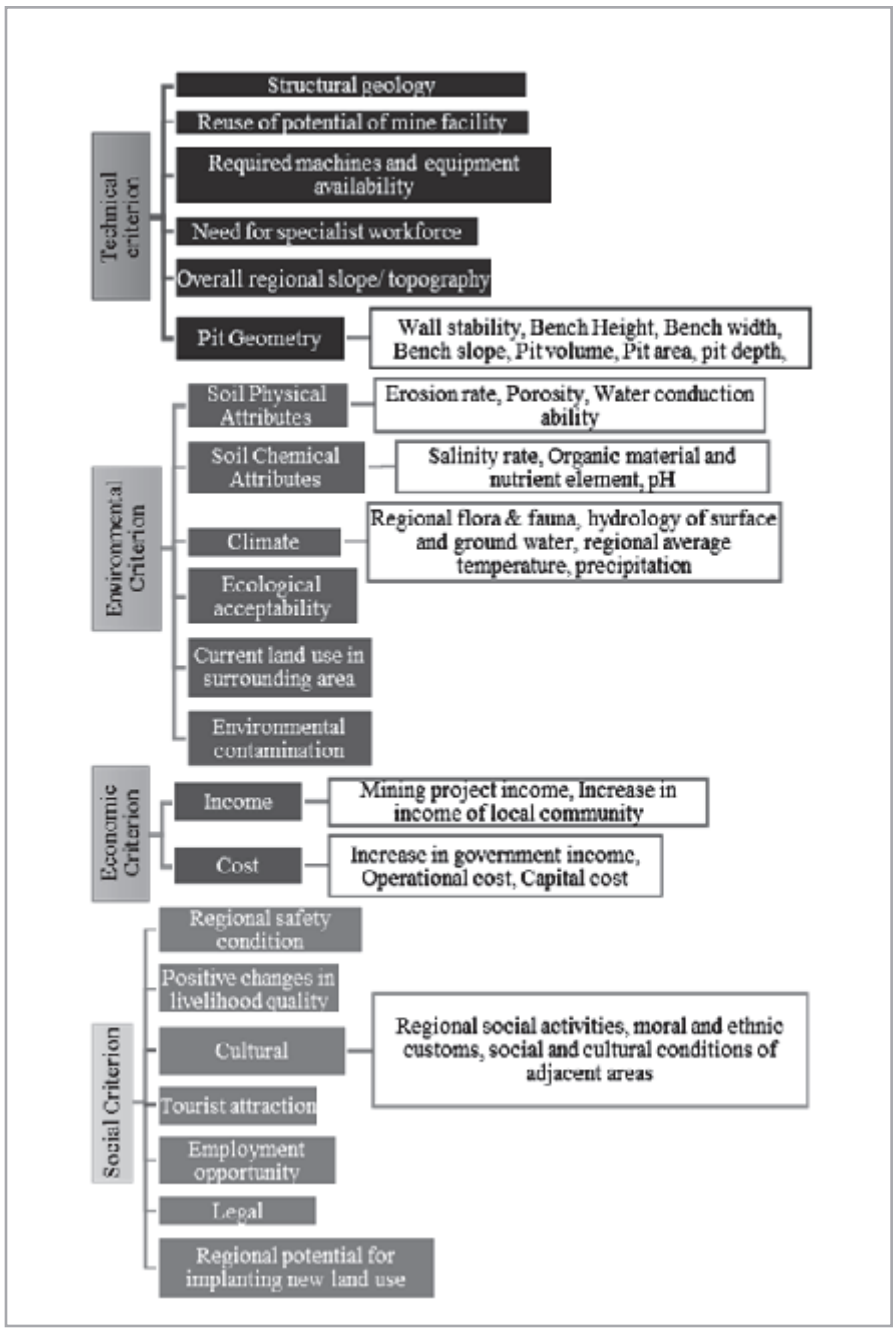

Fig. 4: Criteria for Assessing Closure Alternatives (Source: Eshun *et al.*, 2018)

suggested using the Ecosystem Services Assessment for Rehabilitation (ESAR) framework, which is designed to include community members in mining rehabilitation processes and translate biophysical outcomes into social benefits. The framework has a sequential approach that comprises an ecosystem services review, rehabilitation plan development, the monitoring of ecosystem services, and outcome analysis. The study also highlighted the ecosystem services as an opportunity to fill some current gaps in rehabilitation practices, such as stakeholder engagement (Rosa *et al.*, 2019).

In Australia, several risk assessment methods based on multicriteria parameters were performing well; however, there is a need to improve risk assessment procedures (Lacy *et al.*, 2019). The researcher suggested following the risk management guidelines showing the key processes outlined in ISO 31000:2018 (International Organization for Standardization 2018) as per Fig. 1. Further, Svobodova *et al.* (2019) identified that negative ramifications for coal mining regions involve a complex interplay of multiple risks; therefore, multi-factor risk profiles for operating mines were applied using spatially explicit indicators within a proposed multi-risk framework. It was also highlighted that the use of spatial layers led to classify the region into eight risk categories: stability, water and climate, biodiversity, the vulnerability of land uses, indigenous people, social fragility, political fragility, and regulatory environment, and analyse their effect on a global dataset of active open pit coal mines. This study suggested that conducting risk assessments and incorporating them in mine closure plan may enhance the applicability of the plan.

In Australia, a study emphasized setting remediation objectives as the overall guiding principles and proposed checking every activity against it. In addition, it was suggested that the remediation objective should be clearly defined and understood by the mining authorities and stakeholders (Sanders *et al.*, 2019). Finally, the remediation objective in the mining closure plan should be integrated and followed from the initiation stage (Fawcett and Laurencont, 2019).

Indian approach

General distribution of mining area : As per the Annual Report of the Ministry of Mines (MoM), 2020, the maximum lease area is designated to the mines having an area greater than 500 ha. Out of the total mining area, 53% of mines under lease are greater than 500 ha, 22 per cent mines are in between 200 to 500 ha and the least share *i.e.*,1% is of the mines having an area smaller than 10 ha (Fig. 5). In the lack of appropriate legislative frameworks and controls, the area of mines and their distribution have substantial impacts on environmental liabilities and mine rehabilitation costs.

As per the annual report of MoM, 2020, the total area under lease is 312645.72 hectares and the frequency of the number of leases increased proportionally with the mining area (Fig. 6).

The number of mines which reported mineral production (excluding minor minerals, petroleum (crude), natural gas, and atomic minerals) in India was 3318 in 2014-15 as against 3722 in the previous year. Out of 3318 reporting mines, 498 were located in Rajasthan followed by Andhra Pradesh (444), Gujarat (362), Madhya Pradesh (326), Tamil Nadu (272), Jharkhand (250), Chhattisgarh (201), Karnataka (178), Odisha (173), Maharashtra (150), Telangana (145) and West Bengal (120). These 12 States together accounted for 94% of the total number of mines in the country in

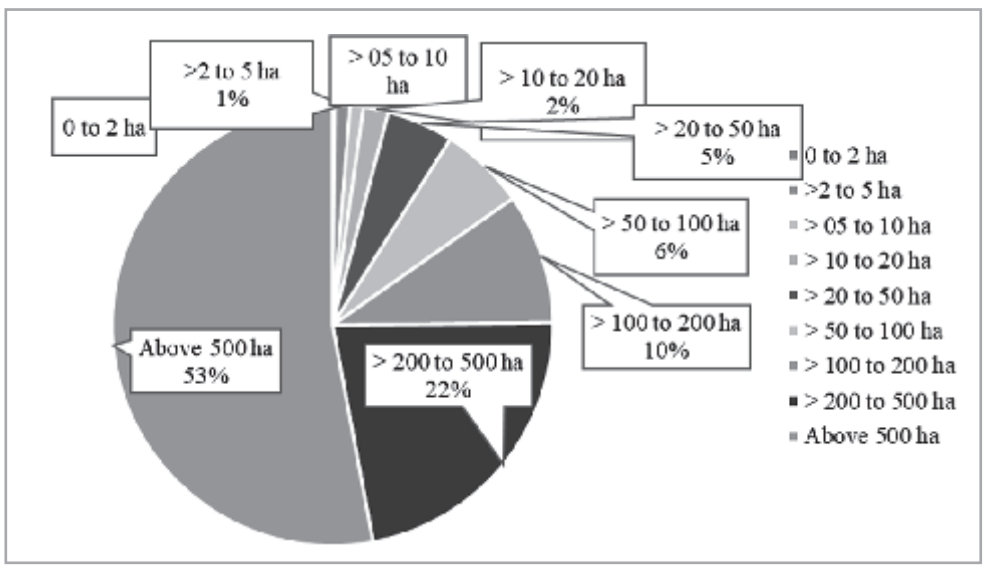

Fig. 5: Distribution of area of mines in India

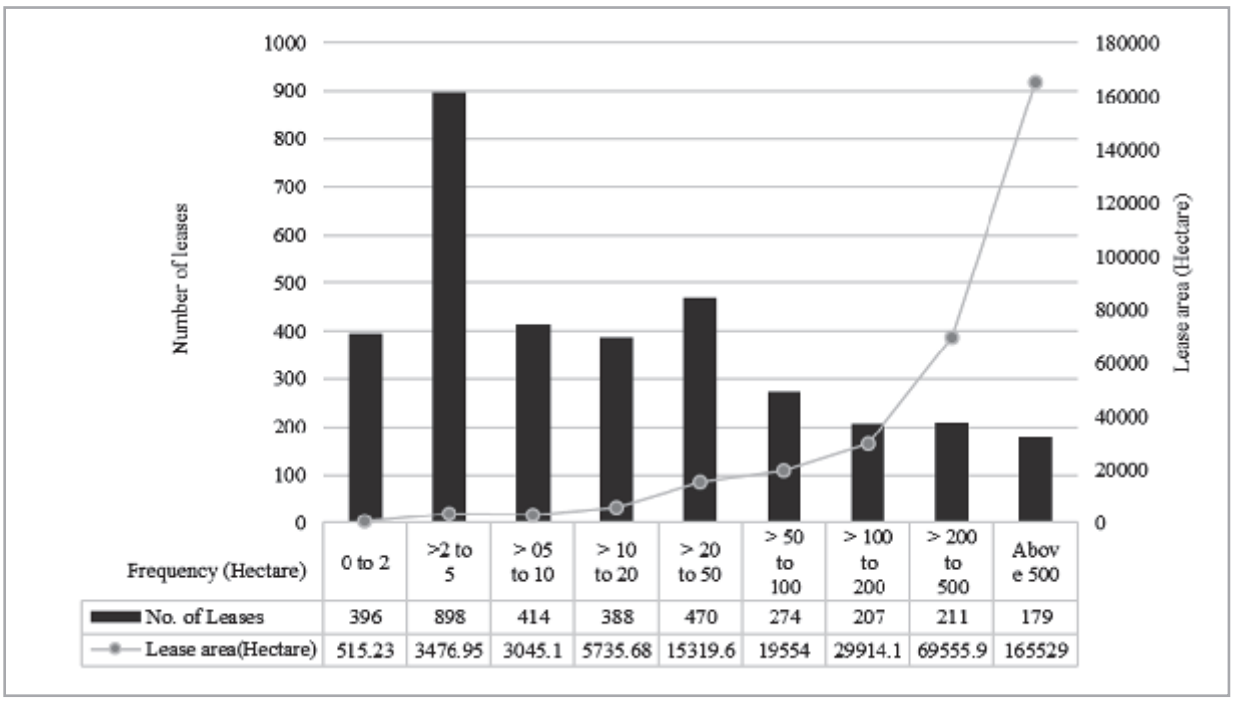

Fig. 6: Number of leases and lease area of the mines in India as per Annual Report of Ministry of Mines for year 2020-21

2014-15. Among them, 575 mines belonged to coal and lignite, 595 to metallic minerals, and 2,148 to non-metallic minerals. In 2020-21 and 2021-22, for the extraction of 40 Metallic and Non- metallic minerals (excluding atomic minerals, petroleum (crude), natural gas (utilized), and minor minerals), 1332 and 1245 mining leases respectively were in force (Fig. 7).

Status of regulation regarding mining closure plan: The Indian Government (Government of India) amended (2012) the Mineral Concession Rules 1960, and Mineral Conservation and Development Rules 1988, vide its Notifications GSR 329 (E) and GSR 330 (E), dated 10.04.2003, respectively. As per these amendments, all the existing mining lessees are required to submit the "Progressive Mine Closure Plan" along with prescribed financial sureties within 180 days from the date of notification. Further, the mining lessee is required to submit the "Final Mines Closure Plan" one year before the proposed closure of the mine. However, the integration of the mine closure plan since the inception of the lease and the vision for future land use utilization plan still is missing from the agenda (IBM, 2003). The Ministry of Mines conducts annual inspections of all the mines under lease and reports all the violations, if any. It is observed (Fig. 8) that the ratio of

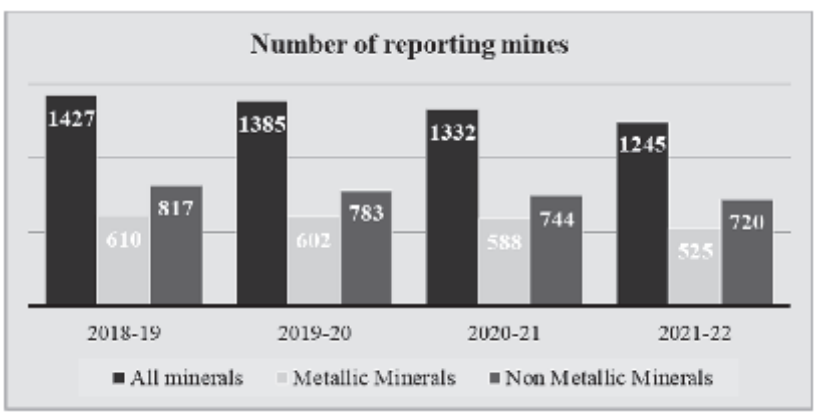

Fig. 7: Number of reporting mines in India in past four years as per Annual Report of Ministry of Mines for year 2018 – 19, 2020-21, 2021-22

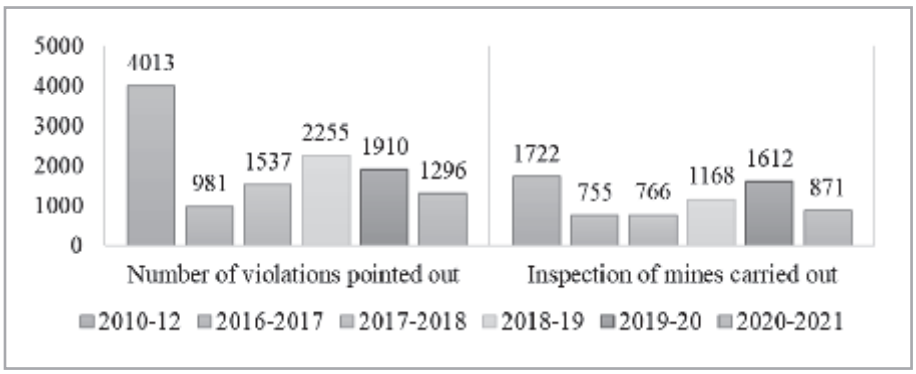

Fig. 8: Inspection and violation statistics of mines under lease in last five years as per Annual Report of Ministry of Mines for year 2010, 2016-17, 2017-18, 2018 – 19, 2019-20, 2020-21, 2021-22

the number of violations to the number of mines inspected has decreased in the past decade (2010-2020). About 4013 violations were recorded from 2010-12 against the inspection of 1722 mines however, only 1296 violations were reported against 871 mine inspections in 2021.

Among the various violations, the violation of mining operations in accordance with mining plan is stated as Rule 11 (1). As per the MoM annual reports, it is observed that compared to 2012, the violations against the Rule 11 (1) has decreased from 721 to 300 (Fig. 9). However, still it is one of the major violation recorded in mines.

The overarching principle of mine closure is premised on the tenet of sustainable development. The Brundtland Commission report (World Commission on Environment and Dev., 1987), which popularised this concept, defines sustainable development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs. The site's long-term environmental, economic, and social performance is apparent after mine closure and completion. However, successful mine closure is determined by the initial mine planning process, which recognizes the need for improved stakeholder involvement and community consultation. Mine site closure planning should occur within the initial mine planning and feasibility assessment phase before the start of mine site operations (Limpitlaw, 2004). In case of unplanned and ineffective mine closure, the region still may continue to be hazardous, and a source of pollution and disturbances after mine operations have ceased. The overall objective of mine closure and completion is to prevent or minimize long-term environmental, physical, social, and economic impacts and create a stable landform suitable for some agreed subsequent land use. The Government of India has acknowledged the adverse environmental consequences of surface coal mining on air, water, and land in the adjoining areas (MoEF&CC, 2016). This adverse environmental impact will become more critical in the future since the total volume of excavation required to produce coal is

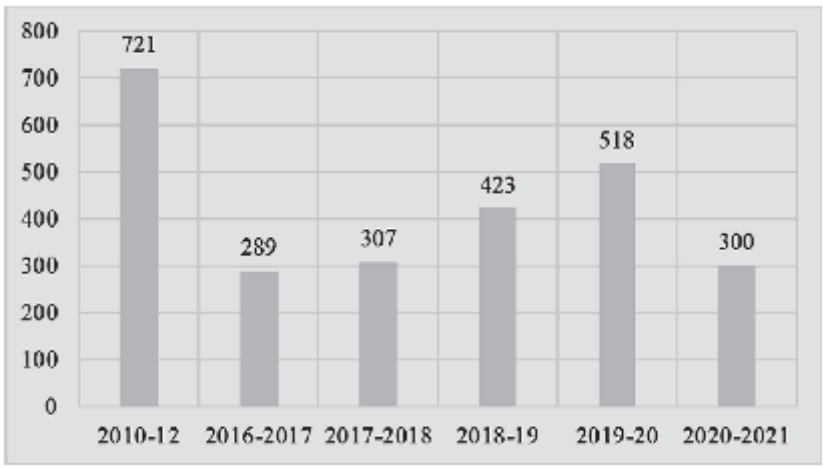

Fig. 9: Status of violation in India under Rule11 (1) *i.e.*, mining operations in accordance with mining plans as per Annual Report of Ministry of Mines for year 2010, 2016-17, 2017-18, 2018 – 19, 2019-20, 2020-21, 2021-22

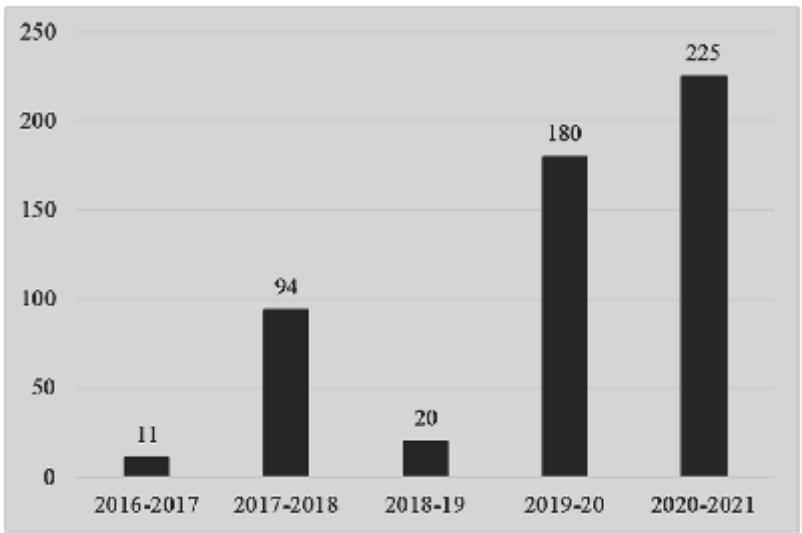

Fig. 10: Status of violations against protection of environment in last five years as per Annual Report of Ministry of Mines for year 2010, 2016-17, 2017-18, 2018 – 19, 2019-20, 2020-21, 2021-22

continuing to increase (Srikanth and Nathan 2017). In 2013, the Government of India revised its guidelines for the closure of coal mines: stating that mining areas must be restored to create a 'self-sustaining ecosystem' (MoC, 2013). However, it is observed that the violation against the protection of the environment has increased in the last five years from 11 to 225 (Fig. 10). This indicates that there is a need for more effective implementation of policies, technologies and practices to counter these violations and handle environmental threats.

In India, Forest Research Institute prepared a roadmap and carried out an ecological restoration and biodiversity enhancement project to reclaim the mining land in Dhanbad under a mining closure of Bharat Coking Coal Limited (BCCL), Government of India. The results suggested that the total number of plant species increased to 105 in 2018 from 58 species recorded in 2013-14. The study estimated that the restoration enhanced the total carbon sequestration of all the species in the soil tremendously (19.60 tons/ha) indicating the revival of the ecosystem from degradation (Chand *et al*., 2018).

According to the Indian Bureau of Mines (IBM, 2019), the closure operation is a continuous series of activities starting from day one of the initiation of a mining project. Therefore, the progressive mine closure plan shall be reviewed every five years in the mining scheme and is directed to be included as an additional chapter in the present mining plan. It also instructs to include a scientific progressive mine closure plan. According to the regulation of the mine closure, the final mine closure plan as per statute shall be considered to have its approval at least nine months before the date of the proposed closure of mine. This period of nine months is reckoned as a preparatory period for final mine closure operations. Therefore, all proposals for activities that have to be carried out after the production of minerals from the mine or mining is ceased shall be included in the final mine closure plan. It is required to submit a final mine closure plan as a separate document with detailed chapters including specific activities as per the guidelines of IBM.

Additionally, the Mines and Minerals Development and Regulation (MMDR) Act (MoL&J, 2015) explicitly requires restoration and reclamation activities to make optimal use of mined-out land for the benefit of the local communities. However, these goals are yet to be spelled out in actionable policies and practices. However, it is observed that in the last decade the frequency of approved mining closure plans has decreased (Fig. 11) in the past couple of years. This indicates that the authorities need to be more stringent regarding the regulation of the final mining closure plan.

Mine rehabilitation and mine closure require a holistic view of mining operations, where each operational stage and component of the mine forms part of mining for closure. It should necessarily consider the complete operating life cycle of a mine, such as planning, mine closure and rehabilitation, post-mine land use and end-use of the site. The mine closure plan needs to be efficient and responsive to the mine site operations. The post-mining land use for the mine site should be defined in consultation with relevant interest groups, including government departments, local government authorities, non-government organizations, and private landholders (Amit, 2017). The self-sustained ecosystem enshrined in India's mine closure guidelines can be interpreted to imply that the restored land must provide a revamped ecosystem and economic services

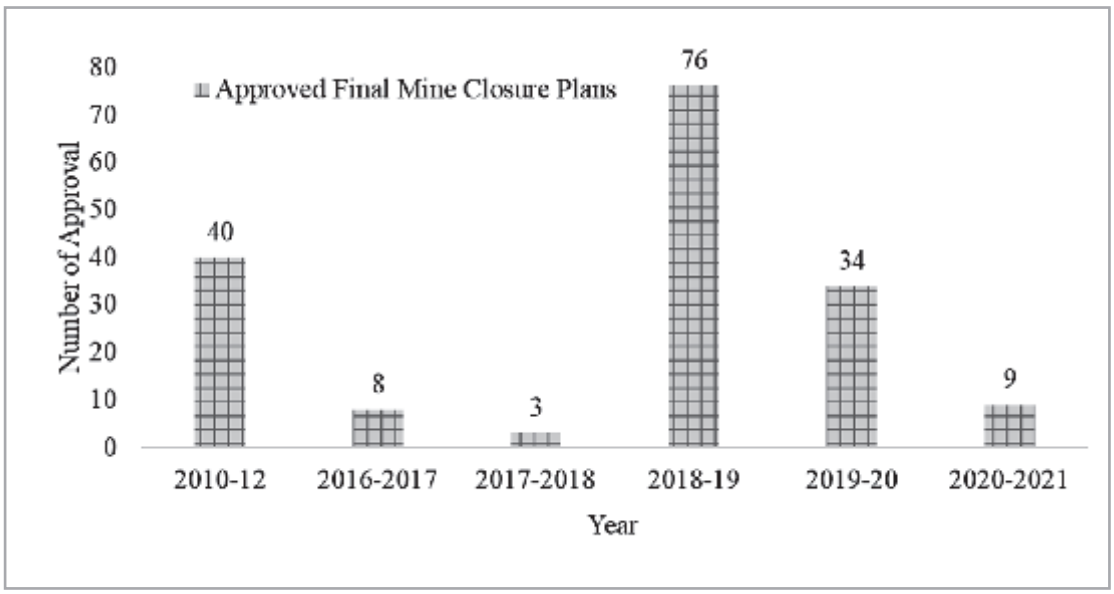

Fig. 11: Status of approved final mine closure plans over a decade as per Annual Report of Ministry of Mines for year 2010, 2016-17, 2017-18, 2018 – 19, 2019-20, 2020-21, 2021-22

Table 1: Highlights of existing mine closure plans in India

S.No.	Mine closure Plan	Year	Organisation	Reference
1.	The mining closure plan will have two components *i.e.*, Concurrent mine closure plan and final mine closure plan for all coal (including lignite) mining operations in India. Final mine closure activity should start towards the end of mine life and may continue even after the reserves are exhausted till its restoration to an acceptable level.	2020	Indian Bureau of Mines, (IBM) Indian Minerals Yearbook	IBM. (2020).
2.	The mining lease is required to submit "Final Mines Closure Plan" one year prior to the proposed closure of the mine. In the notification, it has been enumerated that the "Progressive Closure Plan" and "Final Closure Plan" should be in the format and as per the guidelines issued by the Indian Bureau of Mines.	2018	Indian Bureau of Mines, (IBM) Indian Minerals Yearbook	IBM. (2018)
3.	As per Rule 21(4), the holder of a Mine lease shall not abandon a mine unless a Final Mine Closure Plan (FMCP) duly approved by the competent authority, is implemented, and for this purpose, the lessee shall be required to obtain a certificate from the authorized officer, as the case may be, to the effect that protective, reclamation and rehabilitation work in accordance with the FMCP or with such modifications as approved by the competent authority have been carried out before abandonment of mine. It must aim at leaving the area in such a way that rehabilitation does not become a burden to the society after mining operation is over. It must also aim to create as self-sustained ecosystem.	2017	Indian Bureau of Mines, (IBM) Manual for FMCP	IBM. (2017)
4.	All coal mine owners shall adopt a Mine Closure Plan for each of their mines comprising a progressive closure plan and a final closure plan duly approved by the competent authority.	2013	Ministry of Coal, GOI	MoC. (2013)

for the benefit of future generations, particularly those who reside in the surrounding areas. However, if there is a gap in integrating the plan with inception, merely this idea will not be holistic enough. Thus, Table 1 highlights the existing mining closure plan as per IBM and MoC, GOI.

Conclusion

The review suggests that successful implementation and closure programs depend on interlinked factors, although the closure objective is the major factor. The closure of mining is an overarching factor that should drive all the remediation and mine closure decisions.

The review suggests a need to prescribe improved guidelines for mine closure planning; where possible best practice guidelines and mine closure policies should be integrated into the initial stage while providing closure-planning provisions. Current mine closure practices focus on the concept of avoiding future abandoned mines, developed as a result of previously poor mine planning and rehabilitation practices. There is a need to identify the gaps and use advanced methods like multi-criteria decision methods, illustrated as one of the best approaches worldwide. Such methods at the preliminary stage may support in making decisions and integrating the mine closure plan. It was observed that mine closure, planning, and rehabilitation practices had neglected the fundamental concept of post-mine land use and its integration into the plan since the beginning of the activities. The country has been burdened with the legacy of unplanned closures, hazardous mine sites, and unreclaimed lands. To minimize the possible long-term detrimental effects on the environment, sustainable mine planning needs an efficient tracking system throughout. The review attempted to provide an overview of the entire framework and existing gaps for mining in India and across the globe in the context of the objectives, principles, processes and methodologies for environmentally sound closure of mines. However, it is challenging to precisely assess the effectiveness of the policy and regulatory prescriptions. The mining sector is on the rise in India, which requires attention to examine the policies related to the mining closure plan and its effectiveness. How to tackle the undesirable legacy of abandoned mining-affected degraded areas and pockets of land also remains an issue and concern requiring long-term strategy and policy intervention. Keeping in view the approach for sustainability in the mining sector, there is a requirement for more stringent provisions under the present legal framework in years to come.

Gaps and Suggestions

Gaps: There is a need to identify deficits and deficiencies and improve upon the closure of mines principles, planning methods, systematic processes and operational practices environmentally sound, practicably efficient, and socially optimal mine closure in India. Existing mine closure policies and practices recognises the importance of mine closure planning although its integration in the present scenario and implementation since its inception is still a challenge.

Suggestions: An integrated approach to mine closure that takes into account the environmental, social, and economic considerations at an early stage of mine operations (that includes inception planning) and occurs throughout the mining operational process will be essential in actualising long-term sustainable development and effective mine closure and completion practices. It is necessary to maintain the rationale of mining closure plan approvals and mining lease approval since the inception. Along with the use of advance technologies like, remote sensing and GIS for effective mine closure planning are overlooked. However, MoEFCC of India has made it instructed the mining industry to submit the mine plan with the help of GIS mapping and remote sensing data, there is need to further promote it and make the more efficient mine closure plans. Further, the need to check violations against the protection of the environment in the country, a more comprehensive and impactful approach, the mine closure planning framework should explore and include inputs on final land use, legislation, regulation, and agreements, codes of practices and guidelines, corporate policies and standards, stakeholder expectation and characterisation of the biophysical and social environment.

भारत में खदान बंद करने की रणनीतियाँ और चिंताएँ : कार्यों और रणनीतियों पर एक समीक्षा

भारत ज्योति, शची पांडेय, एस. शिवरंजनी एवं विजेंदर पाल पंवार

सारांश

पर्यावरणीय रूप से स्थायी तरीके से खदानों का बंद होना पूरे देश में चिंता का विषय है। खदान बंद करने का व्यापक सिद्धांत संयुक्त राष्ट्र के सतत् विकास लक्ष्यों (SDGs) में भी परिलक्षित होता है, जिसे 2015 में अपनाया गया था। भारत में, खनिज संसाधन निष्कर्षण का बोझ अनियोजित खदान बंद करने और अप्राप्य और परित्यक्त भूमि के बड़े क्षेत्रों की वसीयत पर पड़ा है। हाल के दिनों में खनन कार्य पर्यावरण संरक्षण की परवाह किए बिना दोषपूर्ण तरीकों और गैर-जिम्मेदार प्रथाओं के साथ किए जा रहे थे। इस प्रकार की गतिविधियों के परिणामस्वरूप आसपास के क्षेत्रों में खनन के प्राकृतिक पारिस्थितिक तंत्र की अपरिवर्तनीय गिरावट और हानि हुई है। यह समीक्षा पत्र वैश्विक समानता को उजागर करते हुए भारत में खनन बंद करने के लिए अपनाई जाने वाली विभिन्न प्रथाओं का अवलोकन प्रदान करने का प्रयास करता है। यह समीक्षा पत्र अंतरराष्ट्रीय और भारतीय प्रथाओं और पर्यावरण की दृष्टि से टिकाऊ और विवेकपूर्णता से खनन बंद करने की रणनीतियों और अंतराल की पहचान (या देखने) के प्रयासों के बारे में प्रकाश डालता है। यह समीक्षा पत्र उजागर करता है कि खनन और खदान बंद करने और पुनर्वास की योजना और उसके परिचालन प्रथाओं में खनन परियोजना की शुरुआत में खदान योजना में खनन के बाद के भूमि-उपयोग और इसके एकीकरण को अनुकूलित करने की मौलिक अवधारणा को आंतरिक बनाने में कमी है, तथा खनन गतिविधियों की शुरूआत पर्यावरण पर संभावित दीर्घकालिक हानिकारक प्रभावों को कम करने के लिए, खान योजना को लंबे समय तक खदान बंद होने के बाद पारिस्थितिकी तंत्र की इष्टतम स्थिरता सुनिश्चित करने पर जोर देने एवं खनन चरण और खदान बंद करने के चरण के दौरान एक कुशल ट्रैकिंग और निगरानी प्रणाली के साथ विनियमित करने की आवश्यकता है।

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