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## **ENVIRONMENTAL AND SOCIO – ECONOMICAL IMPACTS DUE TO MINE CLOSURE**

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### **ABSTRACT**

For the past two decade or so, the term ‘Mine Closure’ has firmly rooted itself into the dictionary of mine operators and regulators. Mine closure is more than a managerial-technical-engineering aspect within the mine life cycle. It is also a social incident in the lives of individuals, households, families, communities and local governments. Although mine closure is recognized as an important phase in mining cycle, it still lacks the excitement. This Paper reviews scenario of Environmental and Socio-Economic impact due to Mine Closure.

Keywords: Mine Closure, environmental impact, Socio – Economic impact, Closure Strategy.

### **INTRODUCTION:**

Over the last few years, Mine closure has become one of the most difficult issues facing by Mining Companies, Mining Communities and Mining Countries around the world. For Mining Companies, safety, environmental and social risks can occur and significant liabilities arise if closure goes wrongly. For Mining Communities, mine closure can cause severe distress because of the threat of economic and social collapse – possibly for an entire region. For Government, abandoned mines can bring large environmental liabilities and clean-up costs unless they set the right frameworks. In any case, for both Mining Communities and Government, Mine Closure usually leads to severe reduction in income, and huge impacts on social and environmental mitigation.

### **MINE CLOSURE**

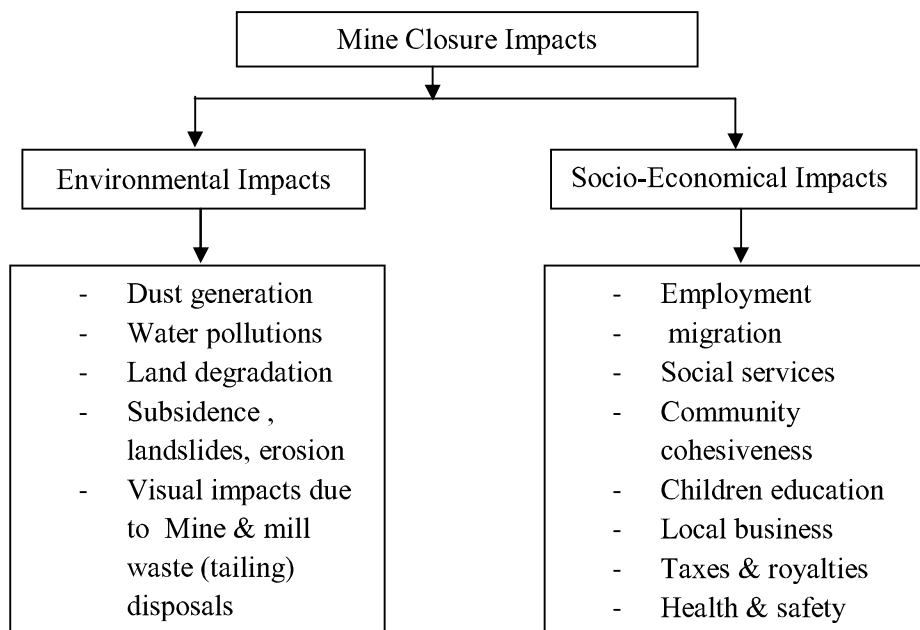
Mine closure is the process of terminating mining operations either temporarily or permanently. Mines have a limited lifespan, which is determined by the quantity and quality of the mineral deposit being extracted. Mines are closed when the ore depletes or deposits becomes unworkable, or the commodity prices drop or low prices of minerals/metals or the low grade of mineral making the mine uneconomical to operate or the mine becomes unsafe or renewal of the mining lease refused or the company loses interest in the Mine (Ryan Menezes, 2006). It typically takes two to ten years to shut down a mine, but it can take longer if long term water monitoring or treatment is required (Canada, 2001).

Due to depletion of the deposit, or when the mine becomes unsafe to work, mines may be closed permanently. When commodity prices drop or market conditions are weak, mines may be closed temporarily as stakeholders expect the situation to change. If however the situation does not improve, the closure may become permanent. Closure of the mine can be planned, sudden or unplanned, and temporary closure (Vladimir P, et al., 2012). In order to reduce the burden of subsidies on the budget, government may demand for the closure of uneconomic mines (Michael H, et al., 2003). Mine closure is the destiny for all mines. Legacies of abandoned mines had in-fact led to the genesis of this concept of mine closure (Singh. S. R., 2013).

## MINE CLOSURE IMPACT

Mine closure can have a positive and negative impact on both the physical environment and the socio-economic structure of the region. Closure impacts encountered include miscommunication over a number of issues, such as community expectations, the ability for the company to deliver on these, company plans, government policy and expectations, as well as the psychological stressors on all individuals and groups relating to closure. Mine shutdown has a major socio-economic impact, with the loss of direct employment and the loss of a major customer base to the service and supply sector.

The closure of the mine serves to highlight and accelerate the already existing environmental and socio-economic consequences of mining, and was indeed a very important risk, not anticipated by many (Mary Ackley, 2008) (Lucrina, 2010) (Clark, A., 2005) (CSR). The impacts of the mine closure are evident throughout India, Romania, Fiji, Russia, Ukraine etc. Ineffective and inefficient mine closure activities in reality leads to interruption of social services, community cohesiveness, together with a downturn in economic activities; it can also be a cause for displacement of communities (Khanna, 2000) (Singh, 2008). Displacement often brings with it economic, social and environmental risks (Ryan Menezes, 2006). Mine closure is multi-factorial and one can't assume that environmental issues are the only issues requiring focus from senior management (Laurence D, 2003). Figure 1 shows the general impacts due to mine closure.



**Figure 1:** mine closure impacts

**Environmental Impact:** Mining is a disturbing activity and causes widespread environmental damage to the region. Contamination of air, surface and ground waters, soil in nearby agricultural land, with chemicals, are as hazardous as cyanide, or just mere salinity, creates public health and safety hazards to the community. Areas with coal reject having the potential for spontaneous combustion (David. L. K., et al., 2013). These factors may lead to relocation or rehabilitation of the community even though their lands are not expropriated.

Mill tailings dumps at Kolar Gold Fields, Karnataka, are creating environmental problems (Surendra, et. al., 2007, Krishna, et. al., 2001). The dumps have hardened over the years and look like hills all around the place, some of them more than 30 meters in height. The natural phenomenon causes the waste to erode and move along the downstream, where the local dwellers are located. The eroded particles in the water regime and air cause health hazards to people (Raja, et al., 2012).

The pollution problems do not vanish once the mining activity has ceased. The abandoned mining sites include large amounts of wastes with a high content of movable metals and particulate matters, which, through their drainage by the rivers or rainfall waters, are carried away and reach aquatic bodies. Due to this reason the abandoned mining sites banks large scale environmental pollution sources. In countries like Ukraine, Romania, China etc., increase in high acidity ( $P^H$ ) and heavy metal loadings takes place as oxidized pyrite remnants are dissolved in groundwater (Younger, P. L., 1993). In India the Raniganj coalfields of coal India ltd., facing severe ground stability problems as a result of numerous abandoned mines i.e. subsidence has occurred in many places (Rao. P. M., et al., 2005).

Also some of the post-closure impacts are hazards due to external sources, i.e., the sources outside the mining area may be flooding from nearby water bodies, flooding/water-logging due to improper outgoing drainage from the mining area, excessive erosion and soil loss, etc. Hazards due to internal sources are failure of pit slope, failure of external dumps, shrinkage of backfilled rock mass along the pit wall contacts, seepage from water bodies formed during reclamation, shrinkage of backfilled rock mass, subsidence, fires. Soil fertility damages due to landslides and erosion from mine and mill waste (tailings) disposals.

Socio- Economic Impact: social impacts are often neglected; the social effects of the mine closure are in the worse condition, as serious as the environmental and economic ones. During the last few years, countries such as Romania, the number of closed mining sites has exceeded that of the new mining projects, thus leading to massive unemployment among the miners (Lucrina, 2010), and therefore, social consequences are unavoidable that included increased alcohol consumption, crime and illegal activities etc., (Bowes-Lyon 2010). The local business community, which once prospered because of its association with the mine, must adjust to leaner times. Local and regional governments, accustomed to taxation, royalties and in many cases, infrastructure provided by the mine (Laurence, 2006), but stops after mine closure. Welfare facilities which were provided at the time of mining activities may not be continued once the mine is closed. This demands to search for alternate forms of livelihood and employment putting them to difficulties of relocation and the inability to find employment with known skills, which may not be useful in the new environment.

The Bharat Gold Mines Ltd (BGML) mines at Kolar Gold Fields (KGF) were closed in 2001 due to uneconomic operations in spite of availability of ore (Sunder Singh, 2012). The adverse effects of BGML closure are poverty, unemployment, alienation and scarcity that have contributed to the increasing criminalization in society. The educated youth travel miles to earn a meagre wage. More than 6000 people, half of them women, travel every day in overcrowded passenger trains to Bangalore, located 90 km away, in search of work (Manjunath A, 2014).

In Romania in 1998, the government offered a generous lump sum financial package to encourage workers to leave the coal mining sector. Over 80,000 workers (about half the industry workforce) took the package – but no measures were taken to create new jobs. Consequently, most of the funds were used for consumption. When they ran out of money, less than a year later, and the workers came back to the government demanding jobs and social assistance (Global Mining 2002).

Table 1: Social impacts of mine closure on aboriginal communities (source: Ross, N., et al., 2008)

Type	Positive or negative impacts	Community response
Social	Decrease in community capacity	Need to acquire new source for resource and capacity.
	Loss of social services	
Economic	Loss of employments	Assist with development of new economic opportunities.
	Reduction in income	
	Unused skills	

Cultural	End of employment phase	Teach skills, mainly through elders.
	Return to traditional skills	

Mine Closures can result in the decline of local economies and a decrease in population, which may have adverse 'knock-on' effects to social services, schools, labour markets, employment, housing prices and other impacts (CSR).

## **GUIDELINES FOR PREPARATION OF MINE CLOSURE PLAN**

As awareness of the need for closure regulation has increased, more countries are in the process of developing legislation and policies.

### **India**

The Central Government vide Notification No. GSR 329 (E) dated 10.04.2003 and No. GSR 330 (E) dated 10.04.2003 amended the Mineral Concession Rules, 1960 and Mineral Conservation and Development Rules, 1988 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 date of notification. Further, the mining lessee 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.

### **Western Australia**

The 2010 amendments to the Mining Act 1978 require a Mine Closure Plan to be submitted to Department of Mines and Petroleum (DMP) for approval as part of Mining Proposal applications received after 30 June 2011. The Plan must be prepared in accordance with these guidelines. The approved Plan must then be reviewed and submitted again for approval by DMP three years after its initial approval, or at such other time as required in writing by DMP.

### **USA**

There are multiple federal environmental laws, plus state and local regulations, that are related to mine closure. Most states with mining activities have state-specific laws as well as regulations with technical requirements and guidance documents for closure. Detailed assessments of conditions during operations and the predicted post-closure conditions are required for a closure permit. Closure plans are required as part of the approval to operate and include estimates of closure costs as well as a financial assurance.

The acts, regulations, policies, and programmes help ensure that the mining company establishes site-specific closure goals and objectives. Regulatory agencies then assess closure plans and make suggestions as required. If the company cannot close the mine properly, the government can use the caution deposit provided by the company before the mine operation phase.

## **MINE CLOSURE STRATEGY TO IMPROVE SOCIO-ECONOMIC STATUS**

Mine closure is however a process, not a distinct event, and the best practice is to start closure planning at the beginning of mine feasibility i.e., Mine Closure Plan should be prepared in draft form prior to the start of production, clearly identifying allocated and sustainable funding sources to implement the Plan (PMA, 2005) (IBM, 2003).

The mine closure plan must define a vision of the end results to be achieved and actions to do so, in such a manner that post-mining area communities health and safety are not compromised, avoidance of physical and chemical damage of the environmental resources, efficient and sustainable long-term use of the site after mine closure, negative socio-economic impacts are minimised and socio-economic benefits are maximised, and the full social and economic benefits of the project will be captured to develop the region (Elizabeth B, et al., undated) (IFC, 2007) (Sassoon, 2000, as cited in Lucrina, 2010).

The closure process must be aligned with community expectations, diminished hazard vectors, current industry expertise, physical equipment and creative governance (Gammon, 2002). Many

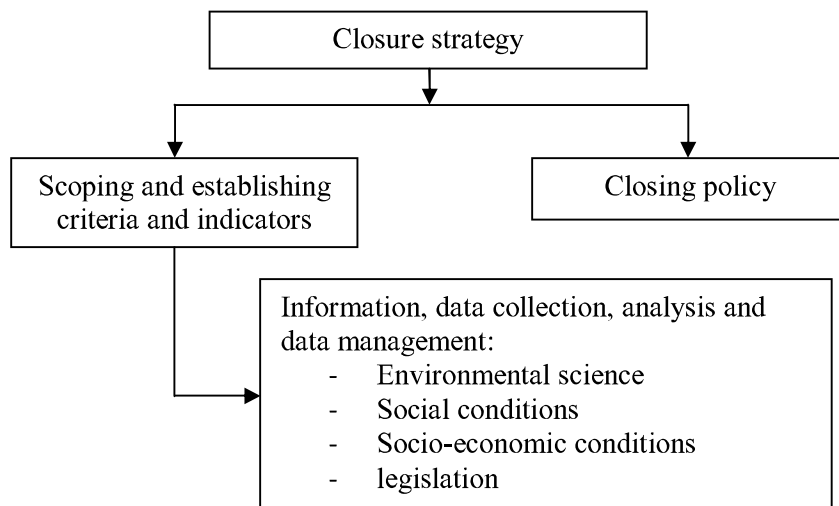
companies are starting to discuss mine-closure impacts with the community in advance of mine operation (Bastida, E., et al., 2005), Public participation ensure that all those affected by a project are consulted and there are opportunities for discussion regarding the long-term issues and the end-use of the site . Company-community relations, governments and non-governmental organizations are therefore critical in determining closure outcomes (CSMI, 2010).

Several actions are necessary in the legal implementation of the principle of preventive action, i.e., national and international standards have to be honoured; environmental information has to be made accessible; an Environmental Impact Assessment (EIA), and socio-economic impact assessment (SEIA) has to be conducted, and penalties liability rules have to be applied. Mine closure in the context of developing countries differs from that which occurs in developed countries, in that alternative socio-economic and environmental options are limited in the former (CSMI, 2010).

Table 2: Mine closure issues around the world (source: Global Mining, 2002)

	Historical legacy of abandoned mines	Large state mining industry closures	Government well prepared today for mine closure	Responsible mine closure
North America & Australia	many	none	yes	Mostly
Europe	some	yes	yes	Mostly
Asia, Latin America, Africa	some	few	no (now starting)	Some
Former Soviet Union E. Europe	few	yes	no (improving)	Some

In the past the crucial concern of company and government officials following mine closure was centred on ways to minimize revenue loss, hazards to public health and safety, and environmental damage. Only lately as a result of increased public pressure has the scope of these concerns widened to include steps to minimize the socio-economic effects of closure on the health of the local community (Roberts, S., et al.), A planned mine closure is necessary to prevent/minimize a long-term negative impact on the environment and socio-economic situations that enables the creation of self sustaining natural systems. The closure of the mine should be seen as a part of an overall strategy for sustainable development of mining (Figure 2).



**Figure 2:** Mine closure strategy (Source: Vladimir. P, et al., 2012)

Effective mine closure involves multiple interrelated concepts, across the social, environmental and economic spheres of development (CSMI, 2010):

- Despite general principles, the social, environmental and economic site-specifics must be taken into account in the mine closure planning.
- Final land use planning must evolve throughout the life of the mine, and needs to be reviewed to fit within developmental, ecological, social and political imperatives as these change.
- Planning for mine closure must include current and future health, safety, environment, community and business risks and opportunities.

As communities are involved throughout the life of mine, they should be familiar and comfortable with the mine closure plan. Community members affected by the mine closure include the employees, their families, suppliers and business owners. Industry and governments are expected to maintain and promote open and transparent discussions with the various community and public (Ross, N., et al., 2008). A growing number of companies now recognize that best practice for mine closure planning must include an effective and inclusive consultation process where local communities are involved and provide input. The Polaris Mine was an example of vision, innovation and success in North Canada. Its innovative closure process demonstrates excellent use of community input through consultation, monitoring and onsite work experience.

Many mineral-rich countries are skills-poor, and have large, vulnerable populations. If mine closures do not translate into further opportunities, the consequent socio-economic problems can potentially affect the entire country (Digby, C., 2012). Orderly, systematic and planned mine closure must facilitate effective rehabilitation of communities facing unemployment and community displacement.

The mine closure plan should take into account environmental, socio-economic factors that will favour the sustainable development of the region. i.e., environmental and socio-economic impacts assessments of the area should be carried out and closure plans should be planned accordingly. The rehabilitation of Gaspé Mines in Canada is a representation of responsible rehabilitation where the economic, regulatory, environmental, public health and social aspects were taken into consideration in order to deliver a project that is perfectly aligned with the sustainable development approach (Carl Gauthier, 2013).

Mine closure while integrating in the mine plan/project report should also be presented briefly in proper format for evaluation and feasibility assessment. The suggested format is as given below (Saxena, N. C., 2008):

1. Objectives of mine closure – The definite objectives of mine closure incorporated in the mine plan should be outlined. The objectives may vary from site to site depending upon the socio-economic, legal and environmental requirements. In fact these should be identified in consultation with the local people and should be in step with the planned post mining land use and availability of the resources there-off.
2. Brief Description of the Mine/Project - Should briefly describe the mine/project covering the name of the project, location, owner, baseline environmental and social status, pre-mining land use, lease detail method of mining proposed, life of the mine, regulatory requirements, environmental and social standards to be achieved during and at the time of mine closure, etc.



3. Post Mining Land Use Plan- Define the planned post mining land use plan considering the aspirations of the society, local resources available, water management, post mining drainage pattern, desired level of post mining economic activities, sustainability of post mining land uses and activities. With the available resources, etc. reclamation and rehabilitation plan/strategies- outline the reclamation and rehabilitation plan in case of both the opencast and underground mines to achieve the desired post mining land use and drainage pattern.
4. Closure Action Plan- This should give a clear indication of various mine closure activities as integrated in the mine plan with a well defined Time frame and interrelationships between the preceding and following Activities. The development of the closure action plan should preferably be done in consultation with the local people.
5. Stakeholders and their Involvement- There should be clear cut understanding of various stakeholders in the development and implementation of the mine closure plan. The stakeholders may be the mining company; Local people, governmental agencies, etc.  
Mining companies have to take constructive action early, and collaborate with communities to plan for economic diversification and create facility long before closure comes into effect. A growing number of companies now recognize that best practice for mine closure planning must include an effective and inclusive consultation process where local communities are involved and provide input. Communities need to be proactively engaged in closure planning, to ensure that the benefits from mining will be sustainable for future generations.

## **CONCLUSION**

Mine closure is an important stage of the life of the mine, and it is most difficult phase challenging the mining industry. Mine closure is an unavoidable stage and planning in the earlier stage will contribute to its final success.

In describing the latest good practices in mine closure planning, it is to note the growing recognition of the social costs associated with mine closure as well as financial and environmental costs. Many companies are starting to discuss Mine-Closure impacts with the community in advance of mine construction and operation. It can be recommended that social impact assessments might become the tool for addressing social impacts in the same way that environmental impact assessments have become the tool for measuring a mine's environmental impacts.

Mine closure is an increasingly complex process, and given the concerns of all stakeholders regarding environmental, social, and economic impacts, best practice has long gone beyond technical solutions. Nowadays, a trilateral process of consultation and problem solving, involving mining companies, governments, and communities, is required for a mine to be closed successfully. In fact, to be fully effective, the process of planning for mine closure should start at the mine design stage. If closure of mining activities takes place in an unplanned manner, disruption of social services, together with a downturn in economic activities are the likely outcomes in a mining region. Therefore, a planned and rational approach is needed to ease direct or indirect impacts on the people and economies affected by mine closure. The mine closure plan should take into account environmental, social and economic factors that will favour the sustainable development of the region. i.e., environmental and socio-economic impacts assessments of the area should be carried out at region where mines are already closed/abandoned to identify the parameters which are affected by mine closure, and closure plans should be planned accordingly.

Socio-economic impact assessment has to be carried out to identify the issues that affect mining communities, directly or indirectly, as a result of a present mine closure plan or policy. This will require the development of impact assessment tools that allow community meeting and input, quantitative assessment and evaluation of different impacts. To evaluate the impacts, an effective mine closure model as to be developed and dominating issues to be highlighted.

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