

MODULE V

ECONOMY AND FINANCES

**IMPROVING ENVIRONMENTAL COMPLIANCE IN MINE CLOSURE:
THE CASE FOR A SYSTEM OF PERFORMANCE BONDS***Dina Franceschi*

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The mining sector presents an interesting challenge in terms of reducing its environmental impacts. Environmental impacts include the emissions of pollutants during the period that mining takes place, transformation of the landscape and the creation of conditions that can lead to environmental problems in the future. Although mining has traditionally been regulated by specifying a set of restrictions on mining activity, this system has not been particularly successful in terms of maintaining environmental quality in areas where mining is currently taking place and in areas where mining activity has been concluded. Although there certainly are examples of mining activity which has been done in a careful, environmentally protective fashion, this is generally the exception. As a consequence, it is essential that we develop a set of new environmental policy tools with which to transform mining into an activity which yields a smaller ecological footprint.

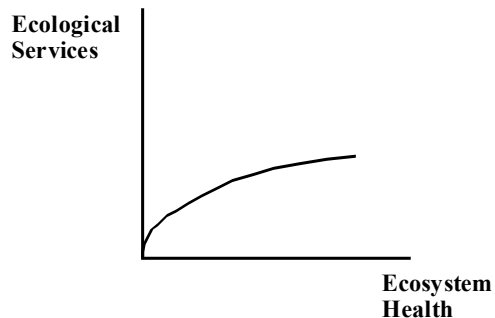
We suggest performance bonding as a policy tool that has the potential to contribute to the solution of the problem. A performance bond refers to a sum of money that is collected from the firm or individual before the potentially damaging activity begins. The money is typically held by the government or a third party (such as an NGO or in an escrow account at a commercial bank) and returned only if the activity concludes within the established restrictions. Although performance bonding has traditionally been used to ensure the restoration of surface mining areas in countries such as the United States and Canada, it has been a narrowly constructed environmental policy. First, it has only focused on the restoration of damages rather than the prevention of damages. Second, it has tends to focus on ensuring a minimum level of environmental quality rather than an optimal environmental policy. Third, it tends to be a discrete instrument, constructed as an "all or nothing" type of control. If the target or restrictions are only slightly violated, the entire bond is forfeited. In addition, there is no reward for exceeding the minimum level.

This paper develops a method which overcomes some of these limitations, transforming the performance bond into a continuous instrument that is capable of preventing damages. Section 2 discusses the structure of the proposed performance bonding system, highlighting its conceptual basis, its theoretical properties, and how it can be adapted to a broad set of environmental needs. Section 3 highlights environmental problems associated with mining in general, with a specific emphasis on mine closure. The section also shows the correspondence between these environmental issues associated with mining and mine closure and the performance bonding system outlined in Section 2. Section 4 provides a demarcation of the dimensionality of these problems both geographically and temporally. Difficulties engendered by temporal and geographical separation are solved by showing how an insurance system can be dovetailed with a performance bonding system. Section 5 details an example of the use of environmental bonding in a hypothetical mine closure example. Section 6 applies the performance bonding system to the artisanal and subsistence sectors of the economy, an area which has proved very difficult to handle with conventional environmental policies.

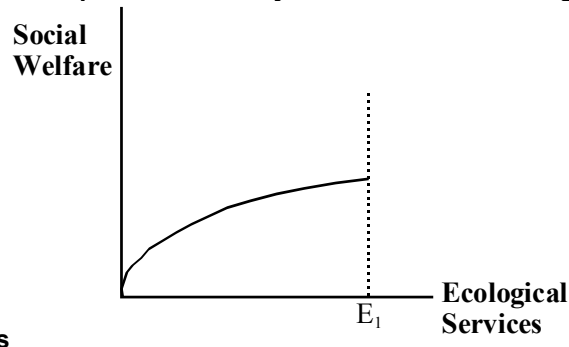
II) STRUCTURE OF A PERFORMANCE BONDING SYSTEM

The proper structure of a performance bonding system will be predicated on the relationship between social welfare and ecological services.ⁱ A reasonable interpretation of this relationship occurs in Figure 1, where social welfare increases at a decreasing rate as the level of ecological services are increasing. An important observation is that most of the social benefits of increasing the level of ecological services occurs before one reaches the level of services associated with a pristine ecosystem, which is E_1 in Figure 1.

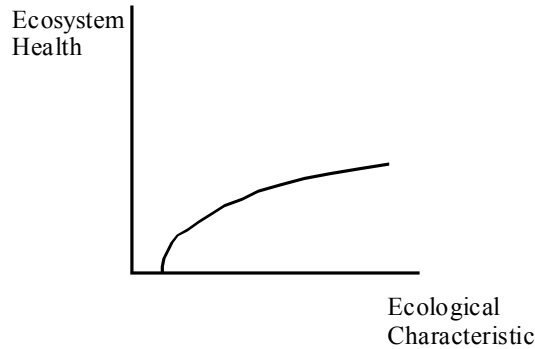
A similar relationship exists between ecosystem health and ecological services. This relationship is depicted in Figure 2. However, from a policy perspective one might want to focus on key ecological characteristics which contribute to ecological health, since ecosystem health is an outcome rather than a choice or control variable. The relationship between an ecological characteristic and ecosystem health is contained in Figure 3. Note that in this depiction, the ecosystem crashes as the level of the ecological characteristic approaches a low, but positive levelⁱⁱ. The three relationships in Figures 1-3 can be linked to derive a functional relationship between social welfare and a key ecological characteristic. This is done in Figure 4, forming the basis for structuring a performance bonding system. This relationship can be viewed as measuring the total social benefits (TB) of the ecological characteristic. TC represents the total costs of obtaining the ecological characteristic, and is presented in this graph as a linear function. The linearity of the cost function is chosen solely for ease of exposition, and does not represent a hypothesis concerning the shape of the function.



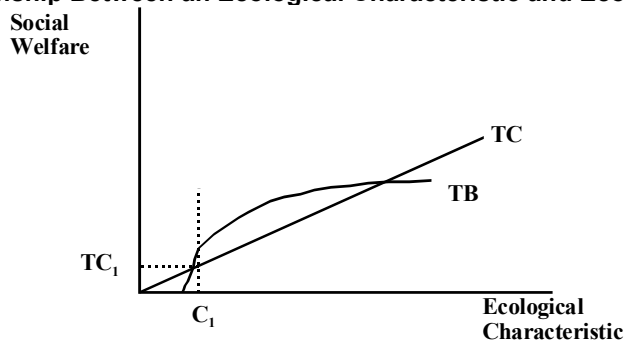
1 The Relationship Between Ecosystem Health and Ecological



2 The Relationship Between Ecological Services and Social



Welfare
3 The Relationship Between an Ecological Characteristic and Ecosystem



Health
4 The Minimum Acceptable Level of the Ecological Characteristic

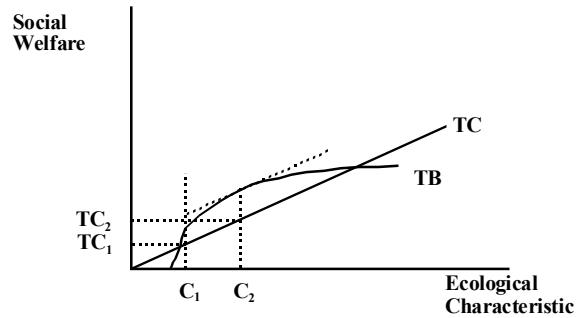
In the traditional performance bonding system, where one seeks to stay above a minimum acceptable level of environmental quality, C_1 would make a good candidate for the definition of the standard. The definition of a level such as C_1 allows one to remain above the collapse point, with an adequate margin of safety to guard against uncertainty associated with either measurement error or stochastic events.ⁱⁱⁱ

To assure that the level of the ecological characteristic remains above C_1 , the magnitude must exceed TC_1 , the cost to the firm of maintaining the ecological characteristic at a level of C_1 . The amount by which the performance bond should exceed TC_1 will be a function of the firm's perception of the probability of forfeiture from violating the standard (the expected value must exceed TC_1) and also will be related to the existence of random variables or measurement error in the total cost function.

However, as mentioned in the introduction, this system does not move society towards the optimal level of the characteristic. The optimal level of the ecological characteristic would be C_2 in Figure 5, where the marginal cost of obtaining the characteristic is equal to the marginal benefit of the characteristic. In this case, the magnitude of the performance bond must exceed TC_2 in order to generate the optimal level of the characteristic.

Returning the Performance Bond

If one is only interested in maintaining the minimum acceptable level of environmental quality the procedure for returning the performance bond is relatively straight forward. The bond is returned if the minimum acceptable level is exceeded, and forfeited if the minimum acceptable level is not attained.



5 The Optimal Level of the Ecological Characteristic

Unfortunately, a corresponding procedure will not work well if the optimal level of the characteristic is the policy target. The reason for this is that if the whole performance bond is forfeited for missing the optimal level of the characteristic, the firm will have no further incentive to maintain environmental quality, and will allow it to decline towards zero. When focusing on the optimal level of quality, there should be a small penalty for being slightly below the optimal level, and large penalties for being far below the optimal level. This structuring of penalties is very important given that the total benefit function is increasing at a decreasing rate, and is likely to be relatively flat in the vicinity of the optimal level of the ecological characteristic. If the total benefit function is known (or if an estimate of the total benefit function is available) then a continuous function of returning the performance bond can be developed as in Equation (1). This function specifies the fraction of the performance bond which is returned, where TB_2 is the level of total benefits associated with the optimal level of the ecological characteristic, TB_1 is the level of total benefits associated with the minimum acceptable level of the ecological characteristic, and TB_x is the actual level of the environmental characteristic at which the firm leaves the effected area.

$$P = \frac{TB_x - TB_1}{TB_2 - TB_1} \quad (1)$$

If $TB_x = TB_1$ (where TB_1 equals the total benefit associated with the minimum acceptable level of the ecological characteristic), then the numerator of Equation (1) will be equal to zero, and all of the performance bond will be forfeited. If $TB_x = TB_2$ (where TB_2 equals the total benefit associated with the optimal level of the characteristic), the numerator of Equation (1) will equal the denominator, and all of the performance bond will be returned. As one moves from C_1 to C_2 , the proportion of the performance bond which is returned increases at a decreasing rate, according to the slope of the benefit function, as illustrated in Equation (2).

$$\frac{dP}{dC} = \frac{dT B_x}{dC} \left(\frac{1}{TB_2 - TB_1} \right) \quad (2)$$

III) ENVIRONMENTAL PROBLEMS ASSOCIATED WITH MINE CLOSURE

Mine closure presents a whole host of potentially long term environmental effects that must be addressed preferably prior to the beginning of mine operation. Most mining firms committed to environmental compliance have found that if the issues are identified and addressed early in the process while recovery efforts are made throughout the life of the mine, environmental mitigation costs can be minimized. In this case, if environmental

compliance is sought throughout, there is no reason to believe that the environmental bond should not be returned in its entirety.

Probably the most significant environmental concern with regard to mine closure is the land surface alteration and degradation that occurs due to mining operations. Reclamation efforts vary for every mine depending on such variables as soil type, contour slope, climate, predominant ecosystem, including preexisting vegetation and wildlife, as well as others. For most mining types, many of the issues associated with mining and land alteration are caused by the mining process itself. The clearing of property and then moving of massive amounts of overburden result in a substantially different topography than had originally occurred on site. Although often times, costs prohibit returning a mine site to the original landscape, efforts are usually required of the firm to integrate the site back into the primary, self-sustaining ecosystem that existed on site before operation began. A key component of mine site reclamation is the choice of proper vegetation and medium term care of the revegetation efforts. Vegetation selection will impact almost every aspect of site reclamation, especially the mitigation of erosion and the return of wildlife.

In addition to land use, both water and air quality are of concern during the post-mining phase. After pit and plant closure, the primary source of air pollution is a result of the increase in dust particles caused by soil erosion and transport. (During mine operation, dust, heavy metal particulates, toxins and other noxious pollutants can plague mining and beneficiation processes. These emissions are reduced after production ceases when studies have shown ambient concentrations to diminish.) Proper dust suppression techniques, when employed through the production and closure phases of operation can minimize the extent to which post mine damage impacts the surrounding community. Here again, proper revegetation, as well as careful slope contour, can maximize air quality.

Water quality is often compromised during mine operation on site and downstream of production facilities. Issues can vary, depending on mine type. The major problems include acid mine drainage, sedimentation, groundwater disruption, ground or surface water movement and availability disruptions, and toxic leachates. Water control and treatment can occur both in-process and/or end-of-pipe. Technology to mitigate or recycle waters contaminated by effluent wastes, e.g., simple sediment or metals, from production processes is well developed. The minimization of water discharged from the system reduces impacts by limiting either sediments or toxins from entering a local water flow. Surface water runoff can be mitigated by erosion control techniques. The issue of tailing pond leakage or evaporation however, is a more difficult problem. Potentially hazardous effluent discharge, e.g., cyanide effluent, in the case of gold mining, requires careful monitoring and quick response. Any of these issues during mine operation can cause high concentration of effluents which complicate cleanup, closure and bond return.

One of the most common post production water quality concern is acid mine drainage. Water percolates through an abandoned mine site, carrying away any number of mining related contaminants. Careful long term monitoring of the mine site and water testing is necessary to prevent heavy loads of contaminants entering local water flows. Mine site pumping to keep water from collecting in mine sites and/or treatment of the flows is sometimes required. Finally, long term impacts on underground aquifers from subsidence or backfilling post-production, are also sometimes problematic. These occurrences can be unpredictable and also very difficult to reconcile. The environmental bonding system proposed can include a lagged return period, where the bond monies are returned over the course of several years, post production, to facilitate medium and long term monitoring.

Above all the most crucial and complicated component of environmental concern associated with the mining process is the characterization and evaluation of potential impacts before they occur, prior to mine operation. The EIS (environmental impact statement), required in most countries' environmental regulations, facilitates the inventory of existing environmental assets and estimates potential problems and conflicts between the mine operation and the surrounding ecosystem. This process is key to the accurate assessment of the environmental bond. In the mine closure phase of production, the challenge is to meet the prescribed environmental quality standards set out by the EIS, while still remaining within production cost limitations. Of course, the bond is designed to ensure that funds are available for clean up in the event that the firm defaults on their promise.

IV) DEMARCATION OF ISSUES

There are a set of related environmental issues associated with mining and mine closure. First, there are environmental problems associated with mining as the actual mining takes place. These include run-off of sediment, acidified waters and other types of emissions. Second, there are issues of alteration of the landscape and its impact on the ability of the impacted environmental systems to provide ecological services. Both of these types of problems can be adequately handled by performance bonds exclusively, or in combination with other environmental policies such as pollution taxes or direct controls. However, the same statement can not be made with respect to environmental problems associated with mine closure.

The reason that mine closure is more difficult to regulate is temporal in origin. The mine closure must leave the mine and the surrounding environment in a condition that minimizes present and future problems. However, this condition is not self-perpetuating and additional steps may be necessary to maintain this condition long after the mine has been closed. For example, tailing pond dams need maintenance, aquifers must be protected against leakages from waste disposal and contaminated areas, and formerly disturbed areas must be protected from invasion by exotic species.

The first step in the process is therefore to define the set of conditions at which the closed mine and the surrounding environment must be left. A performance bond can then be used to ensure that the closed mine and surrounding area are left at or near their optimal condition. However, the performance bond can not be used to assure the continued maintenance of these conditions over time, as the performance bond would have already been returned to the mining firm and could not provide any additional incentive. Since the conditions would have to be maintained in perpetuity, an additional performance bond could not work as there would be no logical termination point at which point to return the performance bond. Therefore, a second policy instrument must be developed to generate incentives for maintaining the site, protecting tailing pond dams, and rectifying any potential hazards or problems which develop over time.

There are several options which are available to provide this long term protection which are all designed to give either the mining firm or a contracted third party the incentives to provide the long-term protection. One potential policy would be just to establish liability for future environmental damages, where mining firms would be legally required to pay damages to society (through the government) and to individuals if and when future environmental damages occur. This is not likely to be a very good policy because firms may have planning horizons that are shorter than socially optimal, so they may not adequately include the possibility of future damages in today's decision to maintain the quality of the closed sight. Additionally, firms do not have infinite economic life, and if firms

disappear there is no one to maintain the quality of the site. Note that this is a very different situation than that of establishing legal liability for oil spills. Since oil transportation is always a contemporaneous activity, the firms always have an incentive to maintain appropriate safety levels.

Another possibility would be for firms to be required to buy a permanent insurance policy which would insure against environmental damages from the mine site. Insurance companies would then use part of the premium payments (or one time capital payment that they receive) to hire a third party to maintain the closed mine site. Note that this policy not only generates the maintenance after closure, but it also provides the mining company additional incentives to leave the mine in a good condition at closure. The reason for this is that the better the condition of the closed mine and its surrounding environment, the lower the payment that the insurance company would require.

A similar type of policy would be to require the firms to establish a fund which could then be used to pay a third party to maintain the site. This would not be as easy a process, because the government would have to estimate the potential hazards, maintenance require to minimize risk, and so on in order to determine the size of the fund. This would be a similar exercise to establishing the magnitude of the performance bond. Although this could certainly work, it might be better to rely on the market forces and the greater incentive that insurance companies would have to oversee the maintenance process in order to minimize their chances of having to pay an insurance claim from environmental failure of the closed mine.

V) AN EXAMPLE FROM MINE RECLAMATION

In Amazonia, the concerns surrounding mining operations are much the same as in the United States. Land contour degradation, habitat destruction, water contamination and toxic soil seepage top the list. Much of Brazilian environmental policy related to mining is similar to U.S. policy. CONAMA (National Environmental Council) Resolution # 001/86 (amended 009/90 and 010/90) requires an Environmental Impact Assessment prior to commencing mining activity. Constitutional Decree # 99.274/90 authorizes state environmental agencies to obtain licenses from all mining firms regarding mine planning, environmental control planning during operation, and recovery of degraded areas. This decree also authorizes specialty agencies to license operators in highly sensitive environmental regions, e.g., IBAMA (Brazilian Institute for the Environment and Renewable Resources) has specific requirements for mining in the Legal Amazon. Finally, Decree # 97.632/89 requires all firms to submit a Plan for Recovery of Degraded Areas to be approved by the state environmental agency. Federal, state and municipal governments are charged with carrying out these regulations, however, monitoring in most cases is often difficult with agencies severely underfunded. Environmental bonds are sometimes, but infrequently used to ensure environmental compliance.

First, because of the nature of mining operations there is the potential for many more environmental damages to occur (heavy metal leachate, acid mine drainage, particulate emissions, etc.) during the period of operation than in other extractive industries. Second, because of the huge amount of land mass that is moved during a mining project, it is possible that the land area impacted can never be returned to its original ecological state or land use. Success of a reclaimed area then might be the return of as much of the land area to its initially determined baseline state before mining began, while providing some alternative ecological use with the land that cannot be completely restored.

In the rain forest, the issue of tree and vegetation clearing takes on a greater importance than in many other ecosystem types, as all of the nutrients in this type of

ecosystem are stored in the living biomass. Virtually none of the nutrients are stored in the soil. Therefore, replacing the soil and haphazardly planting after mine closure is simply not enough. For a similar style of ecosystem to recover after mining activities are completed, care must be taken in both restoring the nutrient cycle and recreating a distribution of species similar to the original forest system. This is important because the correct habitat must exist to support the animals which in turn are essential to the dispersal of tree seeds that perpetuate the biodiversity of flora.

To ensure the return of environmental quality in this region, the bonding mechanism can be an extremely useful tool. First, we will assume that all of the land can be restored to forest after mining activities cease. If this is the case, a performance bond based on a specialized ecological ratio could enhance the success rate of reclamation activities. This ratio would be conceptually similar to the one defined for the forestry example, except the reclamation process would be dependent on replanting, rather than natural regeneration, because the process of mining would not leave long narrow strips of cleared area that would naturally regenerate.

Criteria used for measuring success of a revegetation project could include:

- the vegetative biomass
- the distribution of tree species
- soil quality (fertility and stability)
- general biodiversity (perhaps measured at a future monitoring date) (Leitch, 1992).
- number of days per year in which fruit can be found in the tract.^{iv}

These characteristics could then be formulated into a recovery index (either weighted or unweighted) and then incorporated into a proportionality function in the fashion of Equation (1). Instead of a single ecological characteristic, the proportionality function would be based on the actual level of the recovery index (RI_x), the optimal level of the index (RI_2), and the minimum acceptable level of the index (RI_1), as in Equation (3).

$$P = \frac{RI_x - RI_1}{RI_2 - RI_1} \quad (3)$$

Although the above method would give a mining firm an incentive to restore the forest, in many cases, this is not technically and/or economically feasible. For example, if a large open mine pit were required to be back filled for reforestation purposes, the mine might in fact turn out to be economically infeasible. Backfilling effectively doubles the cost of a mining project. Instead, a restoration plan could construct an alternative land use for the portion of the mine land that is not recoverable to the baseline state.

Perhaps the largest pit in a project is slated to become a natural lake, allowing it to fill with seasonal rain water that over time will accumulate. With careful, periodic monitoring of the water quality in the lake, this source of water could provide a set of ecological services (albeit different from those provided by the rainforest) as well as economic services (tourism, commercial fishing, irrigation) and recreational services to area residents.

In the area that is not thought to be recoverable back to the forest baseline, a functionality index will weight the potential of this land's contribution to the forest ecosystem, based on possible ecological values of the area and/or anthropocentric use values. This functionality index would vary substantially based on potential alternative uses. In this example, functionality indicators could include

- water quality of the lake (dissolved oxygen, pH, absence of toxic metals and other contaminants)
- water quality downstream of the lake (dissolved oxygen, pH, absence of toxic metals and other contaminants)
- reproductive success of aquatic organisms
- growth rate of aquatic organisms
- biodiversity of flora and fauna in the area surrounding the lake
- aesthetic value and cohesiveness with original ecosystem of the surrounding area
- recreational quality of the area

The functionality index can be similarly incorporated into a proportionality function:

$$P = \frac{FI_x - FI_1}{FI_2 - FI_1} \tag{4}$$

Implementation of a Performance Bonding System in Mining

The first step in the process of implementation of a performance bonding system in a mining context is for the government to decide upon (or the government and the mining firm to agree upon) a restoration plan. This plan would determine which areas of the mining tract would be restored to its original state, and which areas would be restored to some other function.

For the area that is designated to be restored to forest, the first step would be to identify the components of the recovery index, and weights (if any) to be assigned to these components. Next, a performance bond would be established of a magnitude equal to the cost of obtaining the optimal level of the recovery index, RI₂. The performance bond would then be returned based on the proportionality function of Equation (3).

For the area that is designated to be an alternative land use, the first step would be to identify the components of the functionality index, and associated weights (if any). Similarly, a performance bond would be established equal to the cost of attaining the optimal functionality index, FI₂. As with the recovery performance bond, the functionality bond would be returned according to the proportionality function, in this case, Equation (4).

Monitoring

In the United States, the Surface Mining Control and Reclamation Act of 1977 establishes a system of enforcement and monitoring of environmental compliance both during mine operation and after mine closure. During the environmental inspections, all environmental damage mitigation techniques and environmental recovery indicators are inspected for quality. In the reclamation phase, the factors listed above included in the reclamation quality index can be easily tested as the reclamation process moves forward. Usually, a lag of five years or so is added to the end of mine closure in determining the date for full bond return. This allows environmental auditors to determine if the revegetation procedures have resulted in the beginnings of a healthy recovery of the surrounding forest and vegetation.

This type of hands-on monitoring, however effective, is understood to be a costly aspect of enforcement. These additional costs are the primary reason that environmental monitoring and compliance is so sporadic in many parts of the world. However, if the costs

of monitoring are incorporated into the original license fee or into royalty payments, the system can work even in developing countries that typically have under-funded enforcement agencies.

VI) USE OF PERFORMANCE BONDS IN THE SUBSISTENCE AND ARTISANAL SECTOR

We define subsistence activities to include economic activities conducted by families primarily to provide goods for their own consumption. Although some of the production may be sold in markets, the market activity represents a small proportion of total production. In contrast, market sales are the primary focus of artisanal producers. Artisanal producers tend to be small scale operators, with low stocks of capital and unsophisticated technologies in comparison to the corporate sector. Entry and exit from the artisanal industries can be very rapid, for example, the number of artisanal gold miners in the Amazon region varies from 100,000 to 800,000, depending on the price of gold. Examples of artisanal activities include quarrying activities, production of gem stones, gold mining activities, small dairies and ranches, and fabrication of products from recycled materials.

Although subsistence activities and artisanal activities are quite different, they share some common characteristics which increase the difficulty of enforcing environmental policy. For example, both subsistence and artisanal activities often don't appear on the economic "radar screen" and thus are extremely difficult to monitor. In addition, this lack of visibility and extreme mobility in combination with an absence of, or small amount, of fixed assets makes enforcement of environmental fines quite difficult, as it is difficult to fine someone who has no money or visible assets to seize. In addition, there is the very difficult ethical issue of penalizing people who already suffer from poverty. These same characteristics also make the development of a performance bond (with the structure suggested above) very difficult.

However, rather than focusing on penalizing these small scale producers for improper environmental performance, the system we are proposing in this section of the paper would reward these producers for proper environmental performance. The proposed system, which we will call a performance bonus system, can be structured to reduce the problem of encouraging entry.

First, let's look at the case of an artisanal activity, such as the mining of ornamental stone for building facades⁵ or wildcat (garimpo) mining of gold.⁶ Quarrying activities can lead to environmental impacts such as water pollution associated with residues from stone cutting, dumping of waste rock, and noise pollution, while garimpo mining of gold can lead to mercury pollution, sedimentation of the water, and other pollution problem. Yet these artisanal firms are difficult to regulate because of the characteristics described above. A performance bonus can be established as follows. First, decide the periodicity and magnitude of the bonus. The bonus should exceed the cost of environmental compliance, and we will call this level, "Z." Instead of requiring the firm to post a bond equal to Z, the firm is required to post a bond equal to Z (where $0 < Z < 1$) and the government and/or NGOs contribute an amount equal to $(1-Z)$ to an escrow account. This contribution is called the performance bonus.

Then, a proportionality function analogous to Equation (1) should be chosen based on the environmental risks associated with this mining activity. Performance will determine both the amount of the bond which is returned to the firm and the amount of the bonus which is awarded to the firm. For example, if environmental performance is below the minimum acceptable level of performance, the firm forfeits the Z it provided as a performance bond and also forfeits access to the $(1-Z)$ that the government and/or NGOs have made available as a performance bonus. If the artisanal firm's environmental

performance is at the optimal level, it receives all of the Z bond back, plus all of the $(1-Z)$ that is available as a performance bonus. For levels of environmental performance between the minimum acceptable level and the optimal level, a proportionality function of the nature of Equation (1) can be used to determine the proportion of both Z and

$(1-Z)$ that is awarded for the firm.

Additional discussion is needed of the proper determination of the magnitude of Z. Two factors can be identified which should be considered in the determination of this level. First, the greater the value of the firm's assets, the greater should be Z. Second, there is the need to discourage the entry of firms who enter the industry for the purpose of collecting the performance bonus. The greater the potential for the performance bonus system to encourage the entrance of firms, the greater should be to provide a corresponding disincentive.

VII) CONCLUSION

Performance bonds can be very useful tools for achieving specific environmental quality standards if constructed properly. We have discussed a methodology that provides those using performance bonds more precision in the disincentives they give to those creating environmental damages. The approach taken here is directed at promoting environmental damage prevention activities since many damages are irreversible and since prevention of damages is often less costly than restoration. It also strives to achieve the optimal level of environmental quality, as opposed to the typical minimum acceptable level. This base minimum level is often the goal of restoration activities as it ensures complete return of the bond. However, there is no incentive (and in fact likely that additional costs would be incurred, a significant disincentive) in meeting any higher environmental standards with this system. Additionally, structuring this mechanism as a continuous tool so that action can be taken and compensation can be paid according to a variety of different levels of mitigating activity creates a clearer incentive system allowing for a balance between the marginal costs and benefits of environmental preservation (or restoration, where that is the goal).

Although traditionally performance bonds have been used most frequently and somewhat effectively in the mining industry, with a few adjustments bonds can be an effective regulatory tools in many other applications. By instituting a bonding system before disturbance activities begin, regulatory agencies can provide strong assurance that steps will be taken to either prevent damages or restore an area, depending on the policy goal.

The efficiency of the system of performance bonding described above increases with the more that is known about the relationship between social welfare and ecological indicators. While we have good knowledge of this for some ecosystems, more research must be done before the system can be widely employed in its most efficient form. The performance bonding system can still be employed without a knowledge of this functional relationship (based on Equation (1)) but it is less efficient in maximizing social welfare. Even with the current gap in scientific knowledge, integrating estimates of these more comprehensive characteristics of the relationship between social welfare and ecosystem health into performance bonding systems makes bonding a more effective and readily evolving regulatory tool.

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Endnotes:

Ecological services are functions produced by ecosystems such as nutrient cycling, soil formation, carbon sequestration, maintenance of atmospheric chemistry, biodiversity, watershed protection, and so on.

See Kahn and O'Neill (1999) for a discussion of the policy relevance and ecological origins of this type of bifurcation or threshold.

See Bishop (1978) for a discussion of the concept of a minimum safe standard.

Presence of fruit during the whole year is necessary to provide sufficient habitat for large mammals such as monkeys and fruit bats. These large animals are essential to the dispersal of the large seeds (in large fruits) of many rainforest trees. If there is a protracted period without fruit, the mammals will migrate to another area, leaving the area without a seed dispersal mechanism.

See C. Peiter, R.C. Villas Boas and W. Shinya, "The Stone Forum: Implementing a Consensus Building Methodology to Address Impacts Associated with Small Mining and Quarry Operations, *Natural Resources Forum* 24, 2000, pp.1-9.

See Maria Laura Barreto, "Garimpo de Ouro no Brasil:Desafios da Legalizacao", PhD thesis, Escola Politecnica da Universidade de Sao Paulo, Sao Paulo, Brasil.

MINE CLOSURE: SELECTED HIGHLIGHTS

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I - MINING & ENVIRONMENT

Environmental Impacts

- Destruction of natural habitats & changes in landscape;
- Change in water courses & river regimes, clogged streams;
- Land degradation & instability;
- Abandoned equipment & buildings;
- Abandoned surface structures & opened underground access etc.

Pollution Impacts

- Air emission;
- Effluents from concentration & processing;
- Soil contamination;
- Acid Drainage, spills and leaching etc.

Health & Safety Conditions

The nature and the diversity of costs and disarray imposed on environment are exacerbated by means of the following aspects:

- Location Rigidity;
- Competition with other Natural Resources;
- Competition with other Uses;
- Mutually Exclusive Conditions;
- Economic & Social Community Relations;
- Opportunity Costs: *public & private*;
- Opportunity Costs: *present & future*;
- Cost / Benefits: *tangibles & intangibles*;
- Nature of Impacts: *irreversible & perpetual*.

In fact, the real level of sustainability commitment of the mining industry has been under increasing vigilance and questioning considering a series of accidents occurred in the last years (Figure 1).

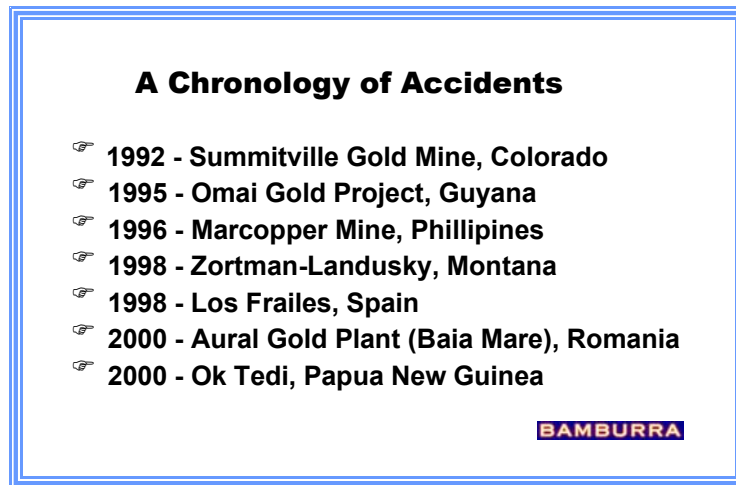


Figure 1 - A Chronology of Accidents

The majority of problems have been associated with:

- Errors in conception & design
- Poor operating conditions
- Spills of cyanide & heavy metals by means of breach & overflow
- Acid Rock Drainage

II - MINE CLOSURE SYSTEM

The challenge imposed by closure of mines can be approached like a system composed by five fundamental vectors:

- EBS - Environmental Baseline Study
- EIA - Environmental Impact Assessment
- EMS - Environmental Management System
- Conception & Feasibility Study
- Mine Closure Planning

Figure 2 presents a profile of the relationship between the principal vectors of a Mine Closure System.

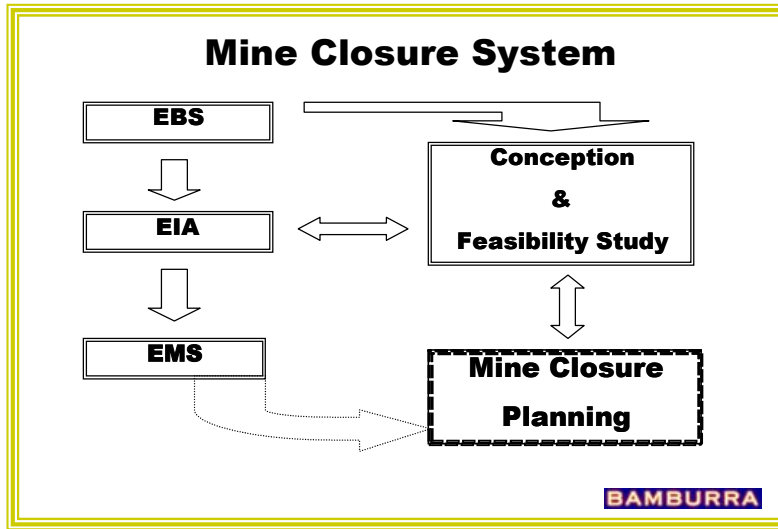


Figure 2 - Mine Closure System

Reclamation & Closure permeates the conception & feasibility interface at the level of its three fundamental dimensions (Figure 3):

- Geological Assurance;
- Engineering Conception; and
- Mineral Economics.

Conception & Feasibility Interface		
Geological Assurance	Engineering Conception	Mineral Economics
Resources & Reserves Continuity of Mineralization Drilling & Sampling Representativity of Sampling Assay Methods & Integrity Margins of Errors Confidence Intervals Quality Assurance & Control Tonnage & Grade Estimates Reclamation & Closure	Tonnage / Grade Relations Stripping Ratio Cut-Off Grade Policy Sequence of Mining Open Pit Design Minimum Minable Width Dilution & Specific Gravity Mining & Processing Routes Mining & Process. Recoveries Oper. Costs & Investments Reclamation & Closure	Supply & Demand Project's Market Price Behavior Oper.Costs & Investments Leasing & Contracting Mine Life Economic Evaluation Financial Engineering Taxation Planning Competitive Analysis Risk Analysis Reclamation & Closure
Source: VALE, Eduardo. (1998)		

Figure 3 - Mine Project Interface

III - MINE CLOSURE PLANNING

That depending of the region and the institutional regime mine closure planning activities embrace all the core segments of the mining industry and the closure and post-closure phases as well. Its basically focused on the rehabilitation and stability of the mine site and the protection of its area of influence. Figure 4 lists the principal areas of concern of a mine closure planning.

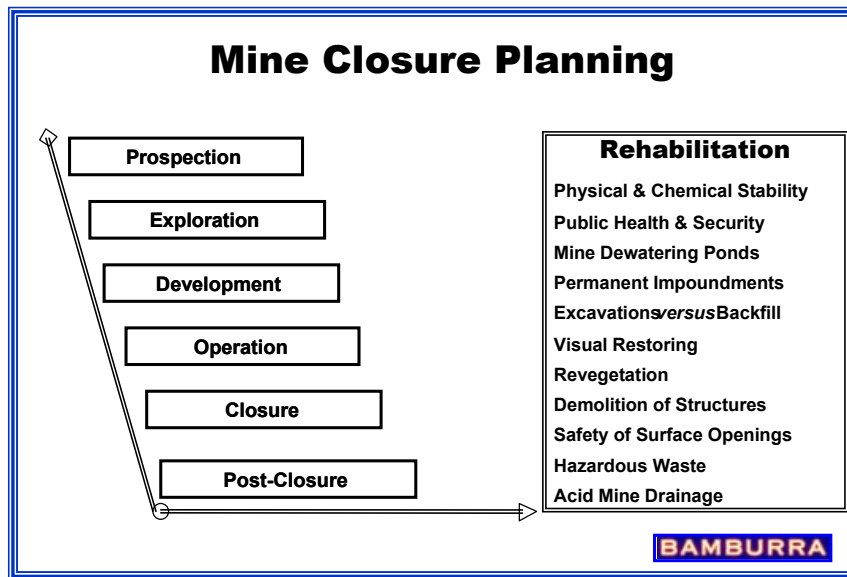


Figure 4 - Mine Closure Planning

In terms of mine closure budgeting the principal topics are:

- Demolition & Dismantle
- Remotion of Infrastructure & Superstructure
- Assets Recovery
- Landscape Reclaiming
- Acid Mine Drainage
- Close of Openings & Underground Access
- Maintenance & Monitoring
- Management
- Training & Realocation
- Socio-Economics Restoration & Redemption

By definition, closure budgeting should be included at the environmental impact assessment and feasibility study levels since it can influence the conception of the project and even degrade its attractiveness. Anticipation of impacts and available options, turns feasible the insertion of the following actions:

Prevention & Protection;

Control & Monitoring;
Descommissioning & Closure;
Remediation & Rehabilitation.

IV - CLOSURE BONDING

Bond Calculation - Closure budgeting

Life of Project Bond - A lump sum deposit

Phased Bonding - Gradual integralization of the financial guarantee. Usually, during development and operation.

V - FINANCIAL ASSURANCE - OPTIONS

Cash

Surety ou Performance Bond

Irrevocable Letter of Credit

Dedicated Trust Fund

Properties & Assets

Certificates of Deposit

Savings Account

Self-Bonding

Surety by other Company

Government Bonds

Insurance

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THE ECONOMIC AND TAXATION ASPECTS OF MINE CLOSURE*Nelson Lara dos Reis*

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ABSTRACT

This paper analyses the foundations for the creation of an economic policy based on taxation and accounting procedures, aiming at the lawful implementation of mine closure management (to be understood as environmental recuperation and protection management, following the cessation of the exploitation work due to the exhaustion of a mineral deposit).

There is no doubt that the activities related to the closing of a mine should be considered as one of the basic elements to integrate the mining project since its inception. Also, there is no question that the planning and scheduling of a mine closure should be considered as a determining factor for the sustainable development of the community and the country where the mine has been opened.

Doubts exist, however, about the feasibility of the procedures to be implemented for mine closure, specially regarding its economic basis by mine exhaustion.

A series of relevant aspects have been considered by the analysts of the matter, such as the technical and security questions that derive from the termination of the exploitation work, the environmental and administrative problems and the aspects of living quality, together with the decommissioning of the mining area.

Notwithstanding the multiple features of this subject, the economic solution for the mining project is the most complex part, among all other aspects, not only because it involves a series of interested parties, but also because the solutions are various and seldom can be previously ruled.

Under the economic point of view, the closure of a mining project depends upon a viable mechanism to implement it, after the exhaustion of the mineral deposit, taking into consideration that the mining operation has ceased and the economic interest has almost disappeared.

In order to make ends meet, such a mechanism has to be legally enforceable, must be clear in order to bring feasibility to the whole process and should involve consultation and active participation of all interested parties as the State, the Miners, and the Local Community representatives.

Undeniably the State has a particular role in the above mentioned process, not only as a ruler, but also as almost a partner, for the mining project involves interests of the whole society and the State has to manage public assets as a counterpart of its right to impose taxes.

The tax system is, accordingly, the natural political instrument to provide the funds for such a process, based on the national interest that aims at the macroeconomic growing and stabilization.

Summarizing, there are two mechanisms that assure the feasibility of a mining project closure: the official and adequate regulation of the matter and the system for funds allocation for such purposes, upon political support of the State.

One cannot assume, however, that the law alone is sufficient to impose to the miner the duty to create monetary reserves to be used after the ceasing of the mining operation, when there are no more revenues. Also, it is not possible to the Law to foresee all the details of the matter. Details like the amount of these monetary reserves should be carefully examined, due to the ever- mutating social and technical conditions of a mine closure process.

Further, the State cannot oblige the miner to provide such funds out of the limits of his economic capacity, endangering the profitability of the mining project. On the other hand, if such funds are not sufficient to backup the mine closure expenses, serious social consequences may arise notwithstanding political conflicts and possible environmental damages.

For the mentioned reasons, the State is responsible to create a taxation policy providing economic and social solutions for the mine closure process, balancing altogether the miner obligations and liabilities so that public welfare should result from such policy together with technical and operational solutions.

Regarding particularly the taxation aspects of the matter, one must take into consideration that the tax policy ruling the mining activity is considered by mining analysts as conceptually different from that applicable to any other activity.

The fact that the mining resources are not non-renewable already justify specific taxation rules as, for instance, the accelerated deductibility of costs and the future deduction of losses from past fiscal years.

The uncommon risks of mining bring indirect burden to the miners, which can be considered in fact as quasi-taxes. They derive mainly from the social demands, environmental obligations and other type of compensations involving local communities, expenses and administrative guarantees for the performance of mining work and what interests us most, the liabilities deriving from the mine closure.

In view of the above, it is fully justifiable that the burdening moment of mine closure be carefully observed and treated through a taxation policy in order to counterbalance the above mentioned requests and guarantee its full viability.

The idea about this taxation counterbalancing policy is to consider as deductible now for tax purposes the costs to be incurred in the future by mine closure, since in the future there shall be no more operational revenue to support the aforesaid deduction of such expenses.

It is worth mentioning that the modern taxation regimes provide three mechanisms for the compensation of these special risks inherent to the mining activity:

- by anticipating the possibility of deducting the expenses incurred along the development of the mining project;
- by allowing the deduction of the amount of the accrued costs estimated by the time of mining exploration to face the future mine closure expenses;
- by reducing the tax to be levied during a certain time-span as a compensation for the costs to be incurred in the future by the end of exploitation work, when no revenue shall be available;

By enforcing such mechanisms, the State will be collecting less in the present, but shall not be liable to pay out of its reserves in the future, upon ceasing tax collection,

guaranteeing altogether the implementation of a mine closure project which is its basic social and economic duty.

For the proper execution of such tax policy, the State should fix a timing for the aforesaid risks, reducing tax allowances based on the mine closure project duly approved by the authorities, aiming at both the public and the miner interests.

The three types of tax allowances above may be used together or separately but, whichever way used, they should bring to both the miner and the State confidence in the fulfillment of their objectives.

Criticism may exist, however, that the mining activity does not justify allowances since, according to scholars, mining is in no way different from the other industrial activities that may justify the granting of special favors.

Such allowances, however, represent no subsidy to the mining activity. The tax allowances above mentioned could be used to better implement all the steps of mining closure but they cannot be considered as subsidies. On the contrary, they establish a schedule for the collection of tax compatible with the absence of revenues at the time of mine exhaustion, based on the fact that the operational expenses are always deductible, since it reduces the miner's capital. Specifically at such cases, the tax allowance may authorize the earlier deduction of the costs to be incurred by mine closure, in order to adjust the effective tax payable along the time.

Taking into consideration that the mining activity makes use of the State assets, the scholars agree that no subsidies should be granted to it, establishing instead, a tax policy conceptually different as we have seen above, in order to provide peculiar conditions for implementation of a specific task.

By modifying the moment of tax assessment through a coherent tax policy the risk may be counterbalanced without menacing the objectives of taxation, specially regarding public assets.

The question arises, however, as how the results of such economic and tax policy shall be applied.

First of all, the economic means resulting from such tax allowances belong to the State, especially in this hypothesis where they effectively correspond to an anticipation or reduction of the tax due.

Also, the above conclusion results as a syllogism of the above referred statement, considering that such means generated by a tax allowance are subject to a special accounting procedure destined to assure the completion of a mine closure project.

Technically speaking, the product of such tax allowances should be kept aside in a special accounting provision to be used by the time of the execution of the mine closure project.

The Law, on the other hand, has to fix the conditions for the utilization of such means, otherwise they may be lost together with the conditions created for such important work. Eventually specific funds may be created to manage such means, but they have to be connected to the aforesaid objectives so that all such monetary means be sheltered in order to achieve its institutional objectives.

On account of the estimate of time when such means shall be considered necessary, this same tax policy shall have to provide the monetary correction of the

amounts kept as well as its match with the cost of mine closure estimates, as duly approved by the government mining supervising authorities.

Like the various countries with identical or similar problems, the Brazilian government should create an organism to specifically supervise the mine closure projects.

Finally, there are two other issues that, according to scholars, are subject to careful attention: the question of the implementation of all steps of the mine closure project and the follow-up of such work during and after its execution.

Many hypotheses have been considered regarding the type of guarantees used for the implementation of the mine project. Personal grants as well as other guarantees provided by the Law may be used for this purpose, such as mortgages or a group of related obligations.

In fact, all possible guarantees to be created in this field are not always practical and may not always produce the expected results in such a wide spectrum, mainly when a series of factors may modify the reality during the closure phase of the mining project. On the other hand, if such guarantees are imposed as indispensable, they may turn the mine closure projects impracticable or reduce the interest of investors in the mining activity.

In this respect the most prudent action should be to provide a strict follow-up of the mine closure project by a governmental mining agency permanently helping and assisting the process, avoiding interruptions and coordinating interests, briefly, playing its role for the adequate administration of a public asset.

With regards to monitoring the steps for post-closure maintenance, this is a matter that needs further analysis and greater development.

Notwithstanding the above, it would not be considered an excess to request that the mine closure project includes considerations over the matter just mentioned. Three major questions then arise:

1. Which steps shall be implemented?
2. Who should participate in them?
3. Which are the economic bases for its implementation?

Actually, one cannot request from the miner to support the costs of a post-closure project, for it does not seem to be neither fair nor viable to create another burden in this respect.

If the owners of the mining project participate in another on-going mining project, a suggestion would be to allow the deduction of the costs of such post-closure monitoring process from the operational revenue of this other mining project or to reduce the above mentioned expenses from other Federal Taxes due.

Perhaps this problem may be also solved through granting a special subsidy to the neighborhood communities, thus providing a focused interest and a more efficient follow-up and execution of this work. Maybe the name "subsidy" would not fit the case since it does not refer to a productive activity. Nevertheless, the amount of such "soit-disant" subsidy may be contemplated in the State Budget under the title "public welfare", with great probabilities to be executed due to the cost reduction and political interest deriving from the direct public participation in its implementation.

How can such schemes be accomplished? How to unite people in order to attain such objectives? Certainly, as mentioned before, not only experience is needed, but also

an effective State support to organize such interests and divide the onus, otherwise no prospective success shall exist.

Brazil has not officially regulated the matter in spite of its proved need. Moreover, economic-social factors linked to the reality of the country demand more than a regulation, on account of a special and mutating solution for every case and a constant and judicious follow-up as well.

Therefore, in view of the above arguments, one has to conclude by reinforcing the need for the regulation of the mine closure process, emphasizing the economic basis as a success condition.

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FINANCIAL ASSURANCE FOR MINE RECLAMATION AND THE CLOSURE PLANS

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1. INTRODUCTION

Brazilian mining contributes significantly to the national economy, in the formation of GNP, generation of employment and exports. It represents 4.5% of the value of GNP, excluding petroleum and gas. It is particularly important due to the effects that it brings into the productive structure, including trade sectors and the transformation industry (metallurgy, cement production, chemical industry, ceramic and glass industries). The number of direct jobs - 230 thousand - generates the creation of 920 thousand other jobs in the trade sector and 1286 thousand in the transformation industry. The participation of the State of Minas Gerais in mineral production in Brazil is extremely significant, being responsible for the production of one third of the useful minerals.

In spite of its economic importance and its current technology, mining activity is still regarded as one which brings about environmental problems deserving special attention from environmental agencies and legislators. The adoption of closure plans, which were formerly limited to special cases, is now part of the environmental policy of several countries and it can soon be considered in licensing procedures.

The Brazilian Mineral Production Department (DNPM) have created a Work Group for the elaboration of the Mining Rules. The basic text resultant of this work is now available in the site "www.dnpm.gov.br" for analysis and suggestions from the community. This text proposes that, before the temporary or definitive break in the activities, the mining companies should submit to DNPM a Closure Plan, containing the measures related to environmental control, including those which refer to mine reclamation.

In this context, the mechanisms proposed to assure mine reclamation, which is part of the mine closure plans, have gained great importance in the definition of the governmental policies and in the strategy of the companies

2. SCENERY

The first instrument of mining permits in Brazil was instituted in the colonial period and it ratified the domain of the Portuguese Crown on the minerals, reserving to the royal treasury 20% of the country's mineral wealth, free of any charges. In the subsequent periods, several alterations took place. With the Constitution of 1934, the regime of concession was adopted with the federal domain on the mineral resources (SOUZA, 1995).

The mining taxation system, which was influenced by historical and ideological subjects, has reached the complex picture of the current days, in which the Brazilian industry pays one of the highest taxes in the world. Despite the conclusion of some studies that place Brazil in an advantageous position in relation to mining taxation, after the Constitution of 1988 mining taxation presented a considerable rise, reaching approximately 53.4% of the net income (Table 1).

Table 1: Tax burden in the mining industry of Brazil - (COOPERS & LYBRAND, 1997)

ICMS (VAT)	17%
Financial compensation (government royalties) related to net invoicing, net of taxes, freight and insurance	2%
COFINS (sales levy – exempted when for exports)	2%
PIS (sales levy – exempted when for exports)	0.65%
CS – (income sales levy) – 8% of net income before CS (Social Contribution levy)	8%
Federal income tax – 25% of net income before income tax	25%
Effective tax burden	53.4%

The mining environmental guidelines elaborated by the Ministry of Environment (MMA/ABC/PNUD, 1997), considers that any proposal of control instrument that brings the introduction of new taxes will fail, unless it is based on the substitution of already existent rates or taxes.

The Federal Constitution of 1988 establishes that everybody is entitled to ecologically balanced environment and, along with the government, everybody is in charge of defending and preserving it for the present and future generations. Those who explore mineral resources take the responsibility of recovering the degraded environment, in agreement with the technical solution demanded by the concerning public organ.

The legislation of the states can be more restrictive than the federal legislation, and in this way the Constitution of the State of Minas Gerais is not restricted to the mining industry, extending the obligation to other activities when considering that "those who explore environmental resources are responsible for recovering the degraded environment".

Despite the importance the legislation gives to the environmental aspects of the mining activities, it also recognizes its characteristic of public interest. Act 3.365 of June/41, which is still effective, establishes the dispossession of lands for mining activities, considering them of public utility.

3. ENVIRONMENTAL INSTRUMENTS IN USE

Act 6.938, of August /1981, that disposes on the National Environmental Policy, establishes in its Article 2nd that this policy "aims at preservation, improvement and recovery of environmental quality favorable to life, in order to assure conditions for the socioeconomic development, for the interests of national safety and the protection of dignity of the human life considering, among other demands, the recovery of degraded areas in the Country".

The main governmental instruments of control related directly to the need of mine reclamation are presented below.

3.1. Environmental Impact Assessment- EIA

EIA is the instrument of previous control of projects which can cause damage to the environment, aiming at avoiding pollution or, at least, minimizing it by means of mitigating or alternative measures (CONAMA Resolution no. 01 of 1986). The results of the EIA should be presented in the Environmental Impact Report (EIR), which evaluates alternatives for the project's technology and chosen site and includes aspects related to the construction and operation of the enterprise to be licensed.

Act 97.632 (April/89) establishes that during the EIA/EIR process, the mining entrepreneur should submit a mine reclamation plan to the approval of the environmental agency. It considers that the recovery should return the degraded land to its former condition in agreement with a preset plan for the use of the soil, in order to reach the stability of the environment.

The EIA/EIR usually include issues related to monitoring programs, the future land use and the physical and chemical stability of the rehabilitated areas, but a statutory requirement for a Closure Plan is not common.

3.2. Environmental licensing

Environmental licensing is the procedure by which the installation, amplification, modification and operation of enterprises that use natural resources or are potentially aggressive to the environment are licensed (Resolution CONAMA n°237/97).

In Minas Gerais, COPAM - State Council of Environmental Policy is responsible for environmental licensing. It operates through the specialized chambers, which are advised by the organs of the State Secretary of Environment - SEMAD. The operation license is granted by means of approval of an environmental control plan. For the mining projects this plan contemplates the several stages of the enterprise, and it also establishes the conditions, restrictions and measures of environmental control that should be obeyed. In the environmental licensing process, the decision about the need of elaboration of a closure plan is in charge of the technicians of SEMAD and of members of the Mining Activities Chamber.

The Forest Act of the State of Minas Gerais highlights the mining activities, considering that licensing for mining will depend on the approval of a technical project for flora rehabilitation with local or regional native essences in addition to the project for soil rehabilitation.

3.3. Financial compensation for mineral use

Financial compensation for the use of mineral resources was instituted by Act 7.990 (December/ 1989), and Act 8.001 (March/1990) in which the following percentile for the distribution of these values was defined:

- 23% for States and Federal District
- 65% for the Municipal districts
- 12% for the Brazilian Mineral Production Department that will assign 2% (two percent) for use in environmental projects in the mining areas through the Brazilian Institute for the Environment - IBAMA.

3.4. Compensation for environmental damages

Resolution of CONAMA-02/96 (April/1996) determines that the enterprises projects which can cause damage to the environment should implant any modality of Conservation Unit of public domain to compensate for the environmental damages caused by the destruction of forests and other ecosystems. This compensation can be turned into the costing of activities or acquisitions of goods for the already existent Conservation Unit or for the creation of a new one.

It also establishes that the amount of the resources to be used for these compensations cannot be lower than 0,5% (half percent) of the total costs for the implantation of the project.

The Forest Act of the State of Minas Gerais establishes the obligation of the implantation of forestry and reforestation projects to make up for the occupation of superficial areas for mining.

4. ASSURANCES FOR THE REHABILITATION OF DEGRADED AREAS

There is an international trend to demand closure plans as part of the licensing process of new enterprises. In most cases, this Closure Plan contemplates programs of progressive rehabilitation, a long-term monitoring and a post-closure plan. The rehabilitation in on-going enterprises is usually in charge of the owner or current operator, but in some cases where the recovery is above the financial conditions of the company, the state might have to assume part or the whole cost of the rehabilitation. The greatest uncertainty is related to abandoned areas, where it is difficult to identify the responsible company. In this case the government might take the responsibility (SINGHAL, 1994).

Even if the Brazilian legislation does not define a statutory requirement for a Closure Plan, it establishes through the existent instruments the basis for its effective implementation. Meeting the requirements of all the stages of the permitting process and of all the compensations will assure an adequate behavior from the entrepreneurs, thus fully assisting one of the most polemic tasks which deals exactly with the rehabilitation of the mining areas.

The idea of a financial assurance system for the mining activity is related to the Closure Plan, more specifically to the need of mine reclamation. The mechanism for ensuring that appropriate procedures are followed is a reclamation bond or fund supplied by the companies themselves. The company would get the money back by performing the required work. In situations of abandonment of the mining project due to market conditions or any other reason, the government would have funds to assure the rehabilitation.

In 1997 in Minas Gerais an environmentalist NGO (ANDA) presented to the Mining Chamber of COPAM a proposition which demanded the confirmation of the investor's economic-financial reliability in mining projects, aiming at assuring the recovery of the degraded areas. Later on, this proposition was presented to the State Chamber, but it was not approved.

4.1. Economic aspects

One of the main advantages of the adoption of these instruments is considered to be the incentive to mining companies in planning and conducting the rehabilitation programs, consequently reducing the administrative costs of the agencies of environmental control. On the other hand, the uncertain effects on the balance and cash flow could put the company at risk. Furthermore, some issues lack more precise answers and should be evaluated carefully:

What are the models of deposit or assurance to be adopted and how would they be administrated?

Certainly, the requirement for up-front funding, particularly in the form of cash, will be a problem to many companies.

What should be the value of these deposits or assurances?

There must be a balance. Investments can not be discouraged and the government must have enough funds to accomplish the rehabilitation in case the company fails in its duties.

4.2. Technical aspects

Although the estimate of the costs of rehabilitation is relatively easy to be done, it varies from place to place depending on the technical solution suggested.

In some cases there is a tendency to demand restoration of the area to its original state. The legislation does not impose the physical recovery of the area exactly to it was before. It expects the area's adaptation to a situation of normality and stability. For the application of a system of financial assurance, this issue is of great importance and the cost/benefit of rehabilitation should be taken into account.

Thus, in agreement with the options of future use and of desired degree of environmental complexity, the following situations can be observed:

- Abandonment without specific rehabilitation
- Protection of the area for guarantee of safety
- Restoration of the area to its original state
- Conversion of the area into a new environmental balance
- Conversion of the site into a leisure area (golf course, lakes, parks)
- Conversion of the area for different commercial purposes (pasture, productive forest)

4.3. Legal responsibilities

The company can be considered responsible for the environmental impact associated to its activities even if this impact is caused after its closure. Sometimes this responsibility is defined in a very general way, causing a high degree of uncertainty according to the chosen approach of responsibility (CASTRO, 1996):

- Strict Responsibility: responsibility for causing damages even if the activity of the company is considered legal and cautious.
- Common Responsibility: a company can be made responsible for all environmental problems on its area of influence, even if this company is only partially responsible for the damage. This approach can discourage the retaking of the abandoned mines by other companies, even if this is the most acceptable way of achieving the rehabilitation of the area.
- Retroactive Responsibility: responsibility for damages caused previously to the Act or any specific regulations. It usually implies high costs to define who should take the responsibility. It is estimated that 1/3 of the money collected by the Superfund in the United States has been spent in this activity.

In some cases this situation can lead companies to go beyond the commitments with the legislation, but usually these approaches are criticized for being unfair and for discouraging investments in mining activities.

The retroactive effect of the Canadian legislation demanding financial assurances for on-going mines took into consideration the need of a period of transition for the adaptation of the new demands. It is recognized that up-front funding, mainly in cash, would represent a strong limitation for new investments (REID, 1994).

The system of financial assurances should give the entrepreneur the possibility of the best choice regarding the technical solution for environmental recovery.

Therefore, the flexibility of this instrument should exist in the conception of the project, in the modality of financial assurance to be adopted and in the definition of responsibilities.

5. CONCLUSION

Although economic instruments are not the only solution for environmental management, they present great potential of application. Such instruments should be adapted to the specific conditions of the jurisdiction where they will be applied, considering the legal, economic and technological context.

The application of financial assurance as an instrument of environmental control in the mining projects seems to be an inevitable tendency, but still lacks studies to identify its incidence and effects on the sector. Possibly the companies that operate legally will be most affected, while the illegal ones, which are responsible for secret operations or abandoned areas, will be exempt of any financial obligation regarding the recovery of degraded areas.

Due to the increasing complexity of the environmental legislation and to the great number of effective control instruments in the country (including compensation for the use of the land), propositions that represent new obligations can be made unfeasible, unless they are based on the substitution of the already existent taxes or fees. Therefore, any attempt in this direction should take into account a wide revision of the existent instruments.

In case of application a system of financial assurance, the attributions and responsibilities of the several institutions involved in the licensing process and in fiscalization should be clearly defined in order to avoid differentiated approaches for mine reclamation.

The viability of a certain instrument is widely dependent on its flexibility. Thus, a system of financial assurance should consider the diversity of the technical projects, establish flexible approaches for the definition of responsibilities for the environmental damages and finally operate with a wide range of mechanisms of financial assurance.

Several countries have become stricter regarding their environmental demands thus rising significantly the costs for the mining companies. As a consequence, investments are expected to be directed to those countries where the balance between environmental protection and mining projects is more adequate.

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- i. Ecological services are functions produced by ecosystems such as nutrient cycling, soil formation, carbon sequestration, maintenance of atmospheric chemistry, biodiversity, watershed protection, and so on.
 - ii. See Kahn and O’Neill (1999) for a discussion of the policy relevance and ecological origins of this type of bifurcation or threshold.
 - iii. See Bishop (1978) for a discussion of the concept of a minimum safe standard.