Türkiye 16. Madencilik Kongresi /16th Mining Congress of Turkey, 1999, ISBN 975-395-310-0

SUSTAINABLE ORE RESERVES IDENTIFICATION

Alba J. Castillo
Department of Mining Engineering, Universidad Central de Venezuela, Caracas, Venezuela

ABSTRACT: Searching innovative opportunities to harmonize economically inspired mining operations along with environmental quality standards allows me asking Venezuelan land-use planners to go from exhaustive to oriented.environmental impact evaluations. The goal İs helping in the process of making environmental decisions at the very beginning of the process of identifying mineral reserves, in those cases of regions with both mineral and biological significant resources, both worth to society. Traditionally, ore reserves estimation takes in account multiple factors in a two-dimensional model comprised by Geological Uncertainty and Technical and Economic Feasibility. This paper proposes including a third dimension of Ecological Sustainability based on concepts from Ecological Economy and Environmental Decision Making Science. Premises are: I) going beyond Environmental Accounting; 2) valuing natural assets by their Existence and Option Values; 3) including Public Perception as significant Risk Source; and 4) identifying truly Ecological Sensitivity under specific mining operations with concepts such Habitat Fragmentation.

1. INTRODUCTION

Deciding whether or not exploiting extensive land areas containing economic mineral resources in the Venezuelan Amazon Rainforest Region is a difficult task. In this Tropical Humid Rainforest Ecosystem both, natural biological diversity and significant volumes of ore reserves coincide. It is a remote huge open space hosting great richness on biological communities of unique indigenous tribal people, animal species, floristic species, and uncountable microorganisms, in delicate energy and nutrients flow arrays. Besides that, billions of dollars worth of disseminated refractory gold and diamond ore deposits. Social, economic and environmentalist conflicts have raised ever since no governmental decisions with respect to normative mining policies allowed very-low-restricted gold and diamond exploitation activities in the last three past decades. Last year, a *Sierra de Imataca Region* Land Use Plan Act have reached Venezuelan Supreme Court to legally solve the issue.

Contrary to what has always been thought, non renewable natural resources, such as economic minerals, continue being exploited helping expand human ecological niches. Predictions about worldwide depletion of several mineable economic mineral reserves are yet to be recognized. However, we have been stretching some degradation limits for naturally renewable resources sustaining life quality. And although mineral exploitation is not a leading actor on environmental degradation problems of the global ecosystem, certainly it has a main role in local negative a
Iterations and it contributes to global environmental concerns. In every new mining operations venture, economic reserves are identified with convenient sets of political and economic standards according to financial investment opportunities on the basis of anomalous mineral concentrations.

Traditional mining operations impact local ecological and social-economic-cultural-perceptual factors. Besides increasing local original cash flows and creating manifold job places, mining operations change physical, chemical, even biological, and psychological entities, processes, and conditions. Recent knowledge on Environmental Sciences, such Ecological Economics, establish that the scale of the economy is limited by ecosystems and that a great portion of natural heritage is not exchangeable by humanly manufactured capital (Van Hauwermeiren, 1998).

Korten (1997) writes that global economic production increased from US $ 3,8 billions in 1950 to US $ 18.9 billions in 1992 (dollars of 1987), about five times. This means that, average, during these last four decades we have increased global product much more than that added since the time cavern people began manufacturing stone tools to this century first half. He adds that in this same time period world commercial export increased from US

$ 308 billions to US $ 3,554 billions (dollars of 1990); 11.5 times or more than double of total economic product rate. Figure 1 shows relationships among natural resources and ore reserves historic exploitation which have been giving support to an exponential demographic expansion all along.

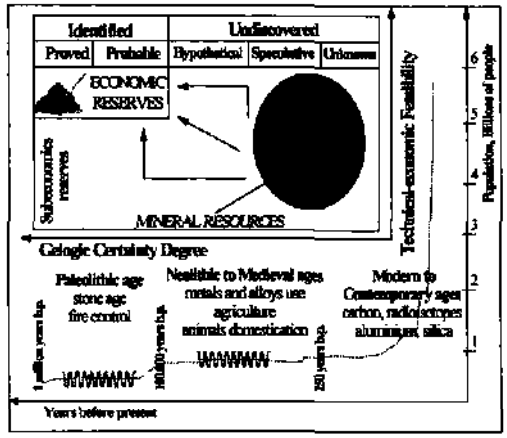

Figure 1. Simplified relationships between historic mineral exploitation and use and human ecological niches exponential growth.

Worrying global statistics indicate that scarcity models also apply to environmental systems as indicated in Figures 2 and 3. Ecosystems are ecological systems whose qualities of components are degraded, naturally and anthropocentric faster rated, in several recognized modes. Rapid reduction of optimal range for life quality of atmospheric, hidrospheric, and lithospheric environmental factors due to significative contamination entering trophic pathways; alterations of physical conditions as local hydrogeological characteristics, and reduction of ecological system dynamics as habitat fragmentation are but few recognized trends.

As simplified in Figure 4, strict economic human development has shown to be not enough to sustain ecosystems equilibrium. At the end of this century it is possible to identify some paradigms on the search of human development, maybe antagonist, maybe not, as it is shown in Figure 5. Among them, deepening democratic regime systems, widening international commerce to make it global, and persuading societies, politically and economically, to look for ways to conserve nature and to extend social welfare and justice. Sustainable Development is an alternative paradigm to Economic Development. There exists a need and responsibility associated to every human affair to think in any alternative way of evolving more harmonic with nature.

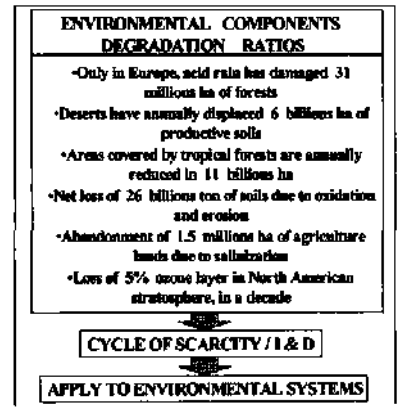

Figure 2. Global environmental factors degradation tends potentially exceeding life sustainability thresholds.

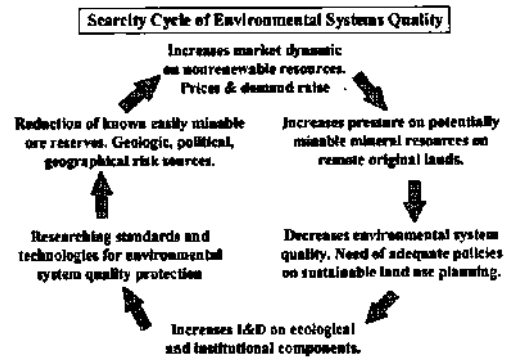

Figure 3. Simplified model of reduction of environmental systems quality factors from mining exploitation human activities.

It is well established that is not sufficient that technical expert people, from science and engineering, give scientific explanations and technical solutions to environmental problems. It is important that professionals dealing with economic and political affairs and socially empowered people

engage responsibly to participate in environmental decision making and problem solving. Environmental Impact Assessments are already performed by interdisciplinary groups of scientists. Notwithstanding, it is necessary to move on more advanced scenarios.

From the Environmental Decision Making Science, it is established that both problem solving and decision making take place in the context of some problem. In the case of complex environmental problems, requirements of wide range knowledge are specially noteworthy, often involving physical, chemical, biological, technological, economic, psychological, ethical, legal, and political factors (Chechile, 1.991). Furthermore, decisions are important not only because they are at the origin of environmental problems, but also because they are at the core of solutions to those problems.

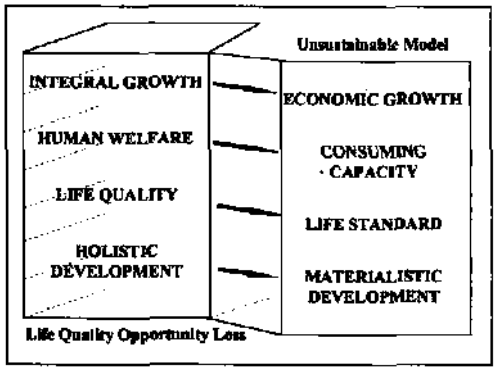

Figure 4. Against sustainable human development, materialistic way of living seems unsustainable.

2. VENEZUELAN MINING-ENVIRONMENTAL LEGAL BACKGROUND: AN EXCERPT

Earlier than 1970, Venezuela had few legal means to conserve nature and too much disconnected to do much. In 1976, Venezuelan government created the State Department of Environment and Natural Renewable Resources and ever since it approved framework federal laws for land use planning and for environmental protection. In 1992, a very modern Environmental Protection Penal Law was enacted and technical standards to protect nature began being devised. In the last four years a set of decrees has been enacted widening the basis of a contemporary and more connected Environmental System of Laws.

Decree 1257 of 1996 derogated the first attempt in 1992 of persuading public and private industries and general society to protect the environment, in this very special decree, it is possible to learn and follow a regulatory procedure to ask for two authorizations or approvals. First, to occupy lands (Land Occupation Authorization, AOT) and later, authorization to affect natural renewable resources (Renewable Resources Affectation Authorization, AARNR). Only after having these two permits from the regulatory officials, a new economic project can start development, mining and oil production included İn Resolution 56.

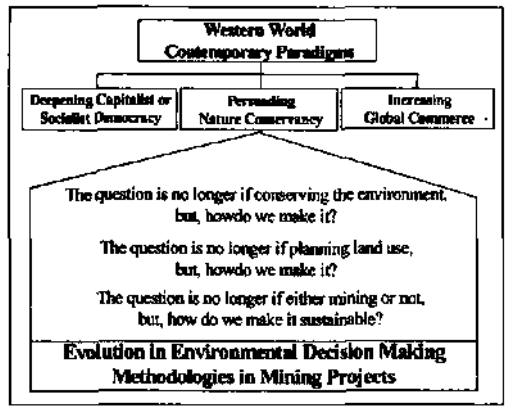

Figure 5. Human needs of paradigmatic changes and concerning questions about environmental decisions.

Then, since 1992 the environmental assessment methodology of Environmental Impact Statement, EIS, has been obligatory required as a technical-scientific tool to help in land use planning and environmental decision making processes. Regulatory officials have been trained and there has been an experience buildup in this matter. Notwithstanding, exhaustive environmental evaluations instead of more oriented systematic environmental assessments and analyses have consumed considerable efforts, money, and honest interests of protecting nature. Reviewing and discussing those reports, concerning ecological and institutional environmental compartments, is rime consuming and it is subject of suspicion from every interest source.

On the other hand, Federal Mining Law dates from 1945 and it has been considered divorced not only of contemporary Venezuelan reality, specially in the matter of financial investments, but also, in disagreement with new policies in environmental conservation premises. There have been at least four mining law projects in the last one or two decades, but each time it has been a failure attempting to reach agreements in the matter. However, ever since 1992, almost all mining operations were required to submit an EIS for starting or continuing mineral exploration and exploitation all over the country.

From the seventies, political parties running federal governments managed significant mineral resources in large areas of the country, specially metallic ores, as means of managing state industrial development. Rounds of populist and classicist policies along with uncontrolled legal and illegal mining operations brought opportunities for corruption and severe damages to local physical and social environmental factors. Ecological as well as institutional negative impacts have prevailed in the Venezuelan Guyana and Amazonian Regions (Bolivar and Amazonas States). National denouncements of illegal mineral exploitation and significant taxes evasion are wide spread. And international warnings of environmental irreversible impacts have been received.

Large environmental debts have been recorded in Venezuela from petroleum exploitation and refining. That might exert some influence in the fact that Venezuelans negative public perception easily raises in apprehension to potential environmental impacts confronted to potentially significant financial investments in mining operations within Latin American region. Lately, Venezuelan government is in the threshold of changes in political and economic systems, so it is so much expectations and apprehension about the future.

Last year there was created a new governmental official agency to manage mineral production economic activities in exploration and exploitation. This agency includes a linkage office with the environmental protection agency searching for agreements in matters related to sustainable mining.

3. MINERAL DEPOSIT EVALUATION

It is denoted that ore reserves classification represents an issue of considerable disagreements and misunderstandings when trying to design systems acceptable to all actors and interests involved in assessment, exploitation, and financing activities of mining projects (Anneis 199I). There exists several proposed models to define ore reserves out of natural mineral resources based on geological certainty and technical and economic feasibility (Leith , 1933; Blandel-Lasky, 1956; US Bureau of Mines and US Geological Survey, 1962). A reserve should satisfy that mineral demand and price being sustained and that economic, politic and environmental factors remain drastically unchanged along mine life time (Gotch, 1988).

Mineral deposit evaluation is a process of fundamentally economic decision making. Risk acceptance and management are at the core of each process step. Among the multiple risk sources environmental risks and public perception risks have lately been getting more relevance. That is a strong reason to think that at this stage of the economic project might be beneficial to both, ecological and institutional environmental factors and mining project investments, to revise the way mineral deposits are evaluated. It İs in the subject of preventing negative impacts that this investigation is developed to help land use planning and nature conservation policies as much as improving empowered public perception about mining projects.

According to Annels (1.991), In Situ and Mineable Reserves must be quoted separately and '-: • hs clearly distinguished. The report should be prepaıeû by a "competent person", who is generally considered to be a corporate member of a professional institution, and must contain a long list of information about geological, economic and technological resources characteristics. As important there are aspects related to whether planning permission have been obtained and mineral rights secured, and also related to the fact that in financial institutions there is a strong feeling that reserves should be audited in the same way as the fixed assets of a company.

4. SUSTAINABLE MINR-JG: A PARADIGM

Since a decade or two, environmental costs have been considered within the economic variable as mineral production costs. That is as an additional set of items in environmental accountability, by way of including them as mitigation measures operational

costs of reclaiming physical-chemical impacts. With this procedure, it can be considered as ecologically extending the conventional definition of markets to environmental impacts by way of traditional price attribution policies.

Environmental impacts prevention policies as means of conserving nature could be perceived as a more advanced philosophical approach than mitigating or correcting variable environmental negative impacts. Although criticized, sustainable mining represents an alternate way to exploit some mineral deposits taking into account risks and effects on natural renewable resources of managing ore reserves. Perhaps, there could be envisaged a quota system of mining ventures in a specific region on the basis of an ecosystem economic limited carrying capacity.

This investigation paper proposal explains the conceptual phase of including a third dimension with multivariate environmentalist factors to ore reserves identification in the process of mineral deposit evaluation. Figure 6 shows this approach to sustainable mining based on new criteria from Environmental Decision Making Science and Ecological Economy to complement and help revise traditional mineral deposit evaluation. Prior to this, it would be necessary to identify and justify the truly societal need of exploiting an specific economic mineral. Additionally, financial interests might be evaluated in relation to the philosophical approach of opening new mining operations.

Sustainable Ore Reserves, SOR, would result from analyzing adequate parameters out of Geological Certainty Degree, Technical-Economic Feasibility plus a new Ecological Sustainability set of variables. Instead of a mathematically speaking two-dimensional analysis, a three-dimensional one. By one side, geological parameters are related to economic mineral geochemical concentration, spatial configuration, geographic site remoteness, structural geologic and hydrogeological characteristics, and geological source of risks. On the other, technical-economic parameters are related to mineral deposit evaluation methodologies and analytical tools, mining extraction systems, available technologies in worldwide markets, monetary capital to invest in mining venture, geographic-political scenarios, mineral market dynamics of international mineral price and demand-offer opportunities. In Ecological Sustainability, parameters would be considered out of the target of Land Use Planning Policies, adequate for environmentally fragile regions such as Epvironmental Sensitivity Analysis. Also, parameters would be considered out of the targets of Public Perception Risk Management, such as Public Participation Organization and Regulatory Bond Systems for mining involved entities to reclaim negatively affected land areas.

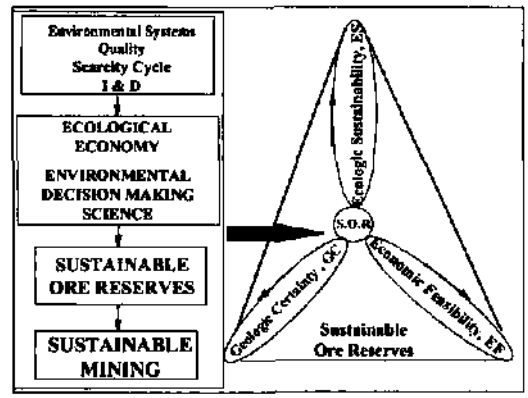

Figure 6. A third multivariate dimension, an environmentalist variable, in the process of mineral deposit evaluation. A new model to evaluate ore reserves.

5. ENVIRONMENTAL IMPACT STATEMENT METHODOLOGY

Environmental Impact Statements have been a very useful methodological tool to predict environmental impacts and design corrective and mitigative measures. In industrialized nations, two decades applying this tool have taught a great deal on the matter. Ecological Functions as well as Psycho-emotional Values are now considered worth appreciating. Figure 7 conceptually Scheines a proposed evaluation process allowing to expand the current environmental impact assessment methodological process İn the specific case of mineral deposit evaluation in ecologically fragile land areas. A concept of Environmental Certainty Degree could be of beneficial use.

From the Environmental Sensitivity Evaluation point of view, Habitat Fragmentation, Biological Diversity and Uniqueness, and Soil-Water System Contamination could be thought as adequate factors to characterize the ecosystem economic carrying

capabilities. However, other set of mineral production conditions could be intersected with the previous ones, such as, Mining Exploitation System, Cut-off-Grade, Minewaste/Ore Ratio, Mineral Dilution Percentage, and Minewastes and Plant Tails Treatment Systems, those factors which characterize a mining project.

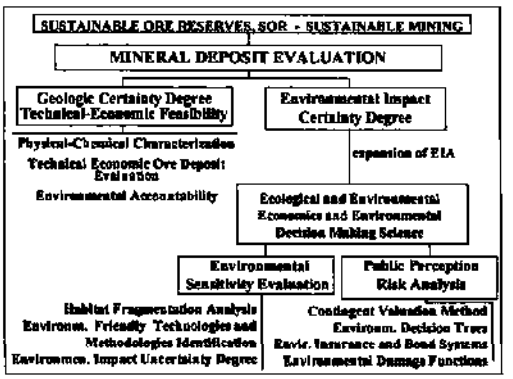

Figure 7. Proposition to expand environmental evaluations in cases of mining projects in ecologically fragile land areas.

In the subject of Environmental Economics, beyond strictly monetary costs, there exists Intrinsic or Existence Value and Option, Use and No Use Values, of Natural Non Marketable Goods. Contingent Valuation Method could be applied to evaluate interests of legitimate actors to exploit mineral resources in ecologically fragile regions. From Environmental Decision Making Science, Public Perception Risk Analysis using Decision Trees for alternative courses for action could be developed to evaluate Risk Acceptance and Risk Management. Finally, Environmental Damage Functions could be applied to estimate the equilibrium point of cost/benefit relationships of reclaiming specific environmental physic-chemical and social-economic factors. These functions are based on Utility Function Analysis from traditional Economic Principles.

Figures 8 and 9 could be taken as possible results of developing and applying this model of sustainable ore reserves identification in which environmental uncertainty and incertitude could be managed. This later probability entity meaning those probable effects that the state of the art of knowledge in environmental impacts are still not known in ecologically fragile land areas. From intersections between classes of environmental impacts and environmental impact certainty degree would be possible to establish Nature Conservancy Policies and Sustainable Mining Project Scenarios.

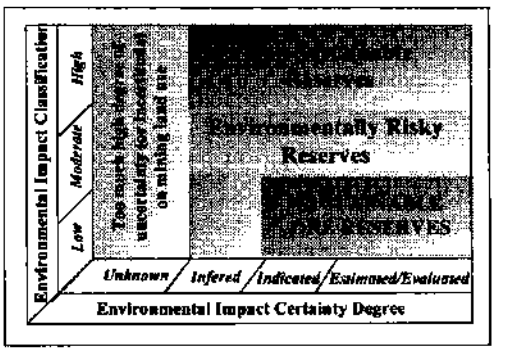

Figure 8. Alternate results for Ore Reserves after developing and applying a sustainable mineral deposit evaluation.

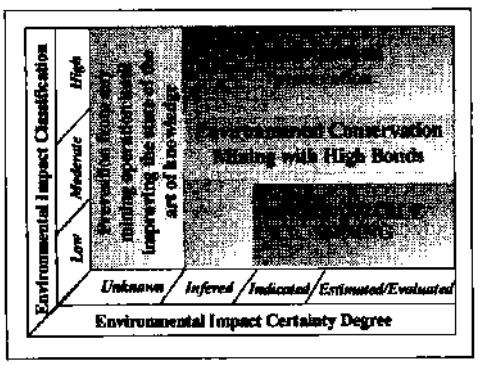

Figure 9. Alternate results for Environmental Protection policies as function of a sustainable mineral deposit evaluation.

Environmental Impact Certainty Degree might result in Unknown category İn a case in which there is no experience about a mining system project developed in an ecological system like Venezuelan Amazon Region, had it be the geographic site case. Inferred and Indicated categories mean there exists

information and records from similar experiences of mining projects developed in ecologically similar areas. Estimated/Measured categories mean that already exist mining operations in the area under sustainable mineral deposit evaluation. On the other hand, Environmental Impact Classification might be weighted assigning relative importance factors to aspects described in Figure 7.

Finally, Figure 10 shows a matrix array to consider mining project capital investment as a way to discriminate from financial support to environmental friendlier mining systems, available technologies and mining operational procedures. This aspect also weights the relative importance that an economic, public or private, senior or junior corporation gives to nature conservancy while managing nonrenewable resources.

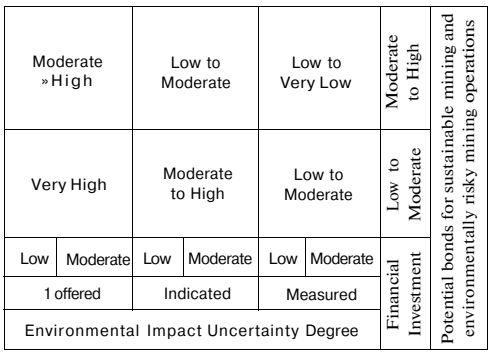

Figure 10. Possible matrix array to consider philosophical approach of economic corporations to nature conservancy contemporary paradigm.

6. CONCLUSIONS

Environmental Negative Impacts could be sensibly reduce had prevention policies been delineated and implemented. Prevention measures, being more realistic and harmonic with a region overall characteristics, need taking İn account non traditional mining development processes. It is possible to go beyond including recent environmental accountability, for budgeting environmental reclamation practices into mineral production costs. It is also possible to go beyond including traditional environmental impact statements, for predicting negative alterations on ecological and institutional factors, to design environmental reclamation practices. Finally, it is possible to go beyond traditional mineral deposit evaluation envisaging a contemporary paradigmatic policy allowing conserving nature while mining nonrenewable resources.

Venezuelan overall society is in need of revising aspects related to convenience and pertinence of exploiting economic mineral resources in ecologically complex land areas, helping with it to bring more rationale and a new set of valuation to ecological factors confronted to economic mineral resources.

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