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Assessment of socio-economic impacts due to mine closure – a conceptual model

Mining activities stimulate environmental and socio-economic impacts on the local and mining communities right from its commencement and continues throughout the life cycle of the mine. The communities in the neighbourhood of mining gradually adopt a typical life-style that is highly influenced by the mining. The impacts exaggerate once the mining activities ceases. Mine closures can result in major adverse socio-economic impacts on local and mining communities, in turn affecting their overall quality of life. Thus, it is essential to predict the socio economic impacts of mine closure on local and mining communities. This paper makes an attempt to develop a conceptual model for post closure quality of life to assess the socio-economic impacts of mine closure on local and mining communities.

Keywords: mine closure, socio-economic impacts, quality of life, conceptual model.

1. Introduction

For the past two decades or so, mine closure has become one of the most difficult issues faced by mining companies, local communities and governments of developed and developing countries around the world. Mines have a limited lifespan, which is determined by the quantity and quality of the mineral deposit being extracted. Mine closure is the process of terminating mining operations either temporarily or permanently. When a mine closes, the impact is often more dramatic than it would be for other kinds of industry, as mines commonly constitute a great proportion of the local economy (Digby, 2012). Mine closure is associated with safety, environmental, social risks and significant liabilities if closure plan fails. In the traditional remote mining town, closing the mine often means closing the town as well, since there are few or no alternative employment opportunities available in the mining town.

In most of the countries including India, mining companies are required to prepare mine closure plans before starting of mining operations and require financial indemnity

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to ensure reclamation (PMA, 2005; IBM, 2003; Redgwell, 1992). Planning for mine closure has mainly focuses on the environmental mitigation and costs of closure as the most essential features of rehabilitation. However, such strict regulations have not been imposed to address the socio-economic impacts of mine closure. The closure of mining activities along with environment, also impacts local economy, demographics, public health, education, anti-social behaviours. Hence, recently the socio-economic impacts are increasingly being recognised as critical. Most of the companies worldwide are now discussing mine closure impacts with the local community in advance of mine construction and operation. Hoskins suggests that socio-economic impact assessments might become the tool for addressing socio-economic impacts in the same way has environmental impact assessments tool for measuring environmental impacts (Bastida, 2005). It is clear from detailed literature survey that the socio-economic issues of mine closure and the impacts on workers and their families, local communities, and the local economy must also be addressed in the mine closure plan. This paper makes an attempt to develop a conceptual model for post closure quality of life to assess the socio-economic impacts of mine closure on local and mining communities.

2. Background

2.1 MINE CLOSURE

Mines are closed when the ore depletes or deposits becomes unworkable or low prices of minerals/metals or the low grade of mineral making the mine uneconomical to operate or the mine becomes unsafe or limitations involving social or environmental aspects, or renewal of the mining lease refused or rationalization and privatization or change in policies of government (Clark et. al., 1998; David, 2006) or the company loses interest in the mine (Ryan, 2006). In order to reduce the burden of subsidies on the budget, government may demand for the closure of uneconomic mines (Michael, et al., 2003). Mine closure is the process of terminating mining operations either temporarily or permanently. Due to depletion of the deposit, or when the mine becomes unsafe to work, mines may be closed permanently. When commodity prices drop or market conditions are weak, mines may be closed

temporarily as stakeholders expect the situation to change. If however, the situation does not improve, the closure may become permanent. Closure of the mine can be planned, sudden or unplanned (Vladimir P, et al., 2012).

The closure involves a group of actions including physical shutdown of the mine and the associated activities, such as final reclamation, equipment removal, community disengagement, employee laying-off, debt settlement (Otto, 2009), water and waste management, etc. Of all the issues, managing the environmental impacts of mining and rehabilitation of mine land after mine closure have been major concerns for governments and mining companies (Andrews-Speed, 2005). It is important that mine closure is undertaken in a planned and effective manner to avoid hazards and pollution in the future. Unplanned mine closure is associated with safety, environmental, social risks and significant liabilities. For mining company and government, unplanned mine closure can bring large environmental liabilities and clean-up costs (Sarkar and Sarkar, 1996) unless they set the right frameworks.

2.2 SOCIO-ECONOMIC IMPACTS OF MINE CLOSURE

Mine closure can have a positive and negative impact on both the physical environment and the socio-economic structure of the region. The closure of the mine serves to highlight and accelerate the already existing environmental and social consequences of mining and without a doubt a very important threat (Mary, 2008; Lucrina, 2010; CSR). Mine closure is multi-factorial and one cannot assume that environmental issues are the only issues requiring focus from senior management (Laurence D, 2003). Ineffective and inefficient mine closure activities in reality leads to interruption of social services, community cohesiveness, simultaneously a decline in economic activities; it can also be a cause for displacement of communities (Khanna, 2000; Singh, 2008). Displacement often brings with it economic, social and environmental risks (Ryan, 2006). Fig.1 shows the environmental and socio-economic impacts due to mine closure.

The impacts of mine closure on the local and mining communities are often severe. Mine closure may result in a sharp decline in their quality of life. Such experiences frequently induce anxiety and stress. The shattering effects of mine closure on the mining communities are manifest in the corrosion of the physical environment, law and order and participation in the community life. During the last few years, in developing countries, the number of closed mining sites has exceeded that of the new mining projects, thus leading to massive unemployment among the miners (Lucrina, 2010), and

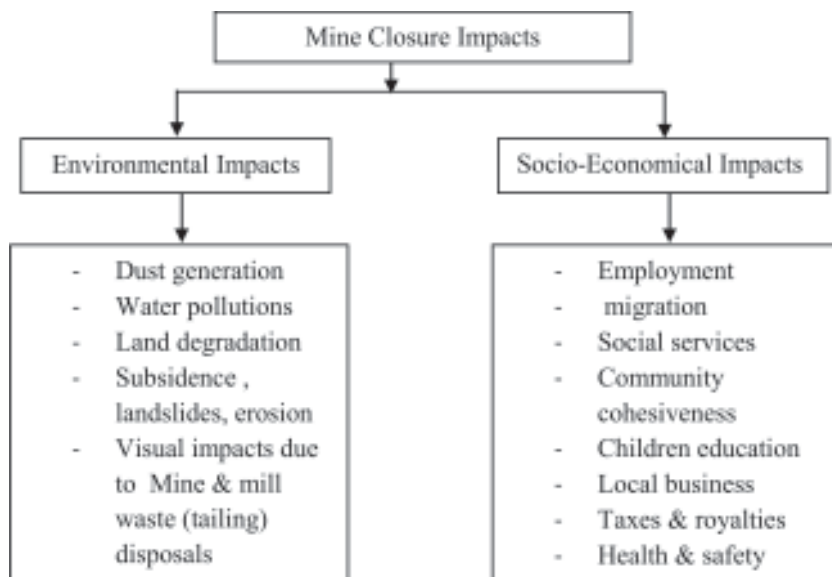


Fig.1 Environmental and socio-economic impacts due to mine closure

therefore, social consequences are unavoidable that included increased alcohol consumption, crime and illegal activities etc., (Bowes, 2010). Welfare facilities which were provided at the time of mining activities may not be continued and withdrawal of a range of informal services which were provided by the mine management once the mine is closed (Michael, 2003).

The local business community, which once prospered because of its association with the mine, must adjust to leaner times. This demands to search for alternate forms of livelihood and employment putting them to difficulties of relocation and the inability to find employment with known skills, which may not be useful in the new environment. In most of the mining regions, a major portion of government revenue comes from mining taxation and royalties (Laurence, 2006). Thus, there is a natural question that after the mine closure will the government be able to maintain the same level of income. Mine closure may leave a severe impact on the government's ability to maintain its services to its citizens. Similarly, mining communities that received direct income from the mine will see a sharp decline in their income.

Thus, it is very important for governments and communities to understand and plan for the possible event of mine closure. There is a great need to develop non-mining activities and other productive assets in every mining region that will last beyond the life of the mine and generate income for future generations. At the same time, it is typically not possible to replace the economic benefits of the mine completely; major adjustments will likely be required.

Mine closure is very crucial and important phase in the mining life cycle, because the post closure impacts of unplanned closing of a mine are severe and pose potential threat to human safety, health and environment (Chattopadhyay, 2001). The major impact of mine closure like

loss of employment, labour migration, discontinued service and facilities, loss of community cohesiveness and environmental degradation have close relation with quality of life (QOL) of the local and mining communities.

2.3 QUALITY OF LIFE

The World Health Organization (WHO) defines “Quality of Life as individuals’ perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns”. For any given family/society the following points should be taken into concern during defining the QOL: that QOL is a dynamic phenomenon and it varies with time and varies according to geographical location and physiographical changes, etc. It depends on the status of development of the people and their aspirations (Saxena, 2008). It is a broad ranging concept affected in a complex way by the person’s physical health, psychological state, level of independence, social relationships, personal beliefs and their relationship to salient features of their environment.

Quality of life is a widely used concept. It is used by common people as well as by governments and local and international organizations. It usually refers to a life which is considered as a good one, well-lived, and being of value (Mariano Rojas, 2009). It may also refer to the presence of those conditions that favour such a good life. Many features enter into the equation and these are not limited to purely material or monetary aspects. The concept of QOL is much wider than standard of living conditions, it also takes into account working conditions, the degree of social integration, health and education, whether people are mostly fragile economically or physically, etc (Albouy, 2010). The concept of QOL was initially applied in the field of sociology, but currently it is commonly applied to other disciplines also such as, disability studies (Jones et al., 1996), social services (Linda, 2005), environment (Robert, 2003), rehabilitation (Fabian, 1990), health, medicine, education (Derrett, 1999; WHO, 1997; Gill, 1994), and others. QOL studies are emerged as unique concept of setting the goals for services and assessing their impacts on people’s routine lives (Felce, 1997) in many developed and developing nations. QOL’s objective is to bring together the developmental change in the individual and their identities, life style and finally make the people to live quality lives.

The mining industry has used several environmental and economic indicators to assess its performance (Azapagic, 2004) in its attempts for sustainability. In recent years, QOL assessment has proved to be one of the best instruments towards sustainability. Mining activities improve the QOL of the mining and local communities, since it contributes direct and indirect employments, social services, local and national economic developments (Figueroa, 2003; Patricio, 2001). But the QOL of mining and local communities may reduce when

mining activities cease. The critical query involved in the present investigation is how mine closure decisions impacts the wellbeing of the mining and local communities.

2.3.1 Measuring quality of life

Earlier to the 1970s for forecasting human welfare only objective indicators were used (George, 1997), during 1970s personal income, housing, education, health and recreational facilities, and environmental factors were recognized as contributors to QOL (Pacione, 1982; Rogerson, 1989). Later, there was a noticeable change in how quality of life was defined and measured. Subjective measures were used to mediate the limitation associated with using objective indicators to measure QOL (Abrams, 1977). In the last few decades, scientists offered several alternative approaches to defining and measuring quality of life: social indicators such as health and levels of crime, subjective well-being measures (Land, 1996) i.e. assessing people’s evaluative responses to their lives and societies, and economic indices (Diener, 1997). These alternative indicators assess three major philosophical approaches to determining the quality of life (Brock, 1993). The first approach describes characteristics of the good life that are dictated by normative ideals based on religious, philosophical, or other systems. The second approach to defining the good life is based on the satisfaction of preferences. The third approach is in terms of the experience of individuals. After reviewing various approaches strengths and weaknesses, Diener (1997) has argued that social indicators and subjective well-being measures are necessary to evaluate a society, and add considerably to the regnant economic indicators that are now favoured by policy makers.

Recent reviews on QOL studies recommend both objective and subjective indicators are essential to measure QOL (Smith, 2000; Felce, 1997). Both subjective and objective approaches find predominance in QOL measurement. Few researchers used both objective and subjective indicators in assessing QOL of mining communities using the socio-economical, political, biophysical, biomedical, and spiritual dimensions (Felce, 1995; Cummins, 2000). The key purpose of the QOL evaluation is to provide a tool for the community development to monitor the living and working conditions of the people and focus on the community actions to improve their living standards. Whether the QOL is measured in terms of subjective or objective variables, to improve QOL one has to streamline objective variables of the QOL. In order to improve QOL of a community, it is necessary to establish a relationship between subjective and objective QOL elements. These elements near a mining area vary drastically with the performance of the industry as well as with the phase of the mining operations. In the closing phase the situations may deteriorate if adequate technical measures were not taken at the planning phase.

3. Methodology

3.1 FRAMEWORK

The objective of the present study is to develop a post closure QOL based methodology to measure socio-economic impacts due to mine closure, which would assist in mine closure planning to overcome negative impacts due to inappropriate mine closure planning. The study attempts to identify the contribution of key socio-economic factors affecting the QOL of mining and local communities living near mining areas. After a thorough review of the available literature it was found that QOL of communities depends on number of factors that are having direct and indirect dependencies on the mining activities. However, these factors cannot be easily measured. Dependencies of the QOL factors and their interrelationships can be evaluated using structural equation modelling (SEM). SEM is considered as an appropriate analytical technique for researches due to its ability to estimate a series of separate but interdependent multiple regression equations simultaneously by specifying a structural model that allows the modelling of relationships among independent and dependent variables even when a dependent variable changes to an independent variable in other relationships (Sorooshian and Salami, 2012).

According to Hughes et al. (1986), there are two strengths in latent variable methods of analysis one technical, one conceptual. Technically, these models provide researchers with a method for estimating structural relationships among unobservable constructs and for assessing the adequacy with which those constructs have been measured. Conceptually, the use of these models entails a mode of thinking about theory construction, measurement problems and data analysis that is helpful in stating theory more exactly, testing theory more precisely and yielding a more thorough understanding of the data (Von der Heide, 2008). The overall methodology used for our study is illustrated in Fig.2.

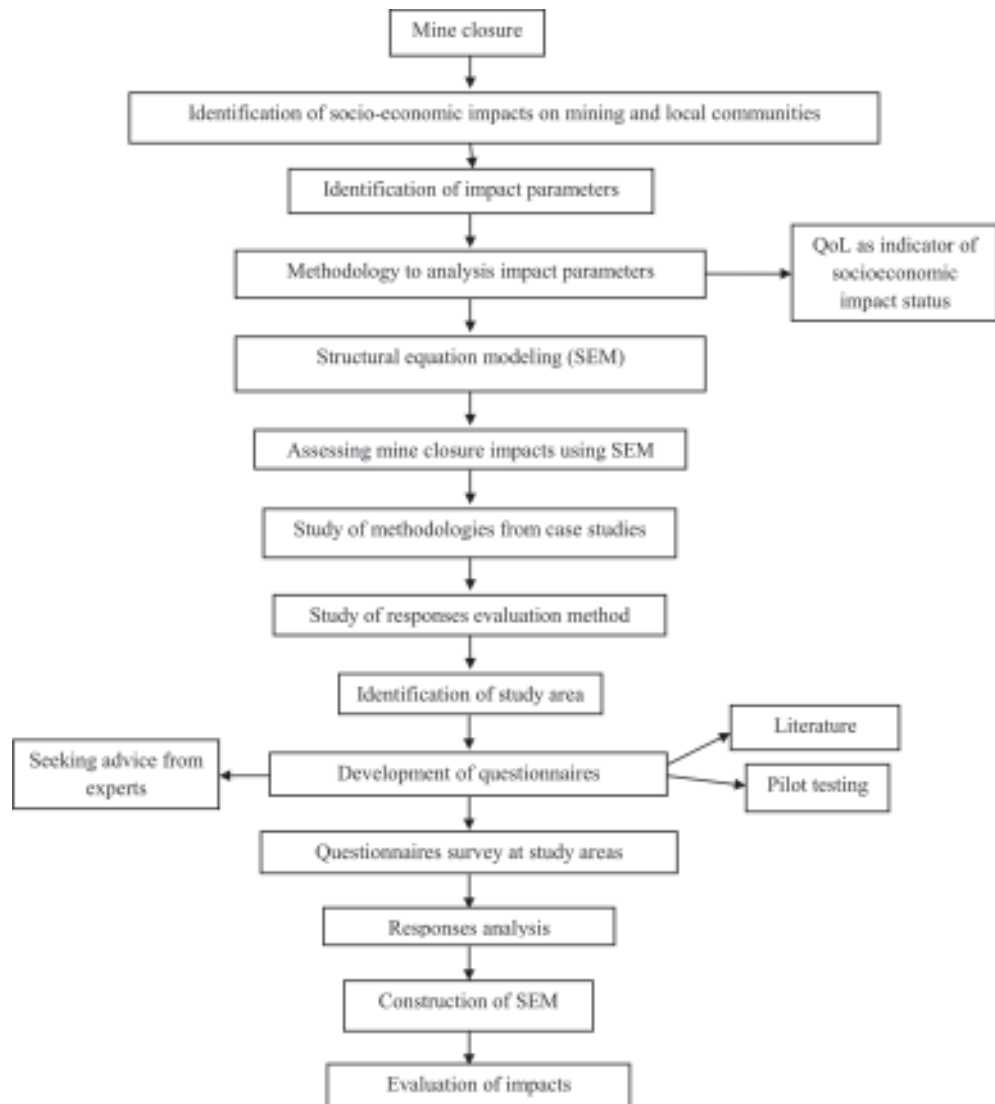


Fig.2 Methodology used for the study

3.2 CONCEPTUAL MODEL

The present study is ongoing near southern part of India, where large underground metal mine which had produced precious metal for more than century was suddenly closed due to uneconomic operations in spite of availability of ore. The adverse effects of this are poverty, unemployment, alienation and scarcity that have contributed to the increasing criminalization in society. The educated youth, adults and ex-miners travel miles to earn a meagre wage. More than 6000 people, half of them women, travel every day in overcrowded passenger trains to nearby cities for job (Manjunath A, 2014). As one of the authors belongs to the study area, most of the facts experienced by the author have also been included in this paper.

For the last few decades or so, scientists offered several substitute approaches to measure QOL using social indicators, subjective well-being and economic indices (Land,

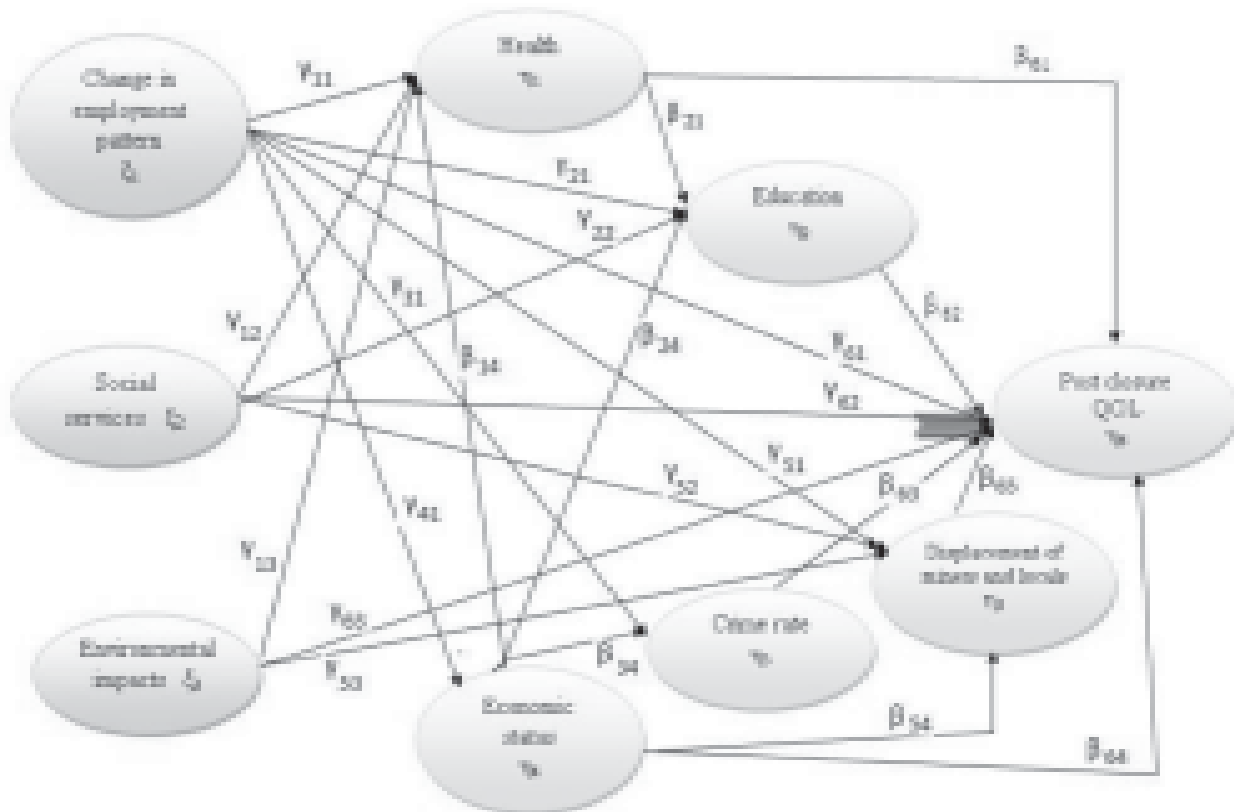


Fig.3 The conceptual post closure quality of life (QOL) model

1996). But QOL is a multidimensional concept and associated with many factors, accounting and identifying all the parameters is quite difficult. Considering the objectives of the study and socio-economic influences of mining, post closure QOL model for a mining and local communities in the mining area was conceptualized as shown in Fig.3. After thorough review of present research work, parameters for design of conceptual model were finalized. The selected parameters are change in employment pattern, social services, environmental impacts, health, education, crime rate, economic status, displacement of miners and locals, and post closure QOL.

Mine closure has a potential long-lasting impact on mining and local communities. The closure of mining activities impacts on the local economy i.e. unemployment, low wages, lack of inward investment; on demographics i.e. emigration of the young and skilled, aging population; on public health i.e. poor housing, unhealthy lifestyles; on education i.e. lack of transferable skills, poor education performance; and the lack of leadership i.e. crime and anti-social behaviour (Digby, 2012).

The immediate impact is the loss of jobs at the mine and income used to support the growth of a community. These economic impacts can have major social impacts. If closure of mining activities takes place in an unplanned manner, interruptions of social services together with a decline in economic activities are the likely outcome in a mining region (ICMM, 2006). The main potential environmental impacts

during mine closure are: land use and water quality i.e. long-term stability of waste rock piles and mining slopes, tailings containment structures and acid mine drainage or metal leaching etc.

This conceptual model is designed to assess the socio-economic impacts due to unplanned closure of large underground metal mines on mining and local communities who were solo depended on mining activities in the study area. From the literature survey it is evident that whenever a mine is closed in unplanned manner, it leads to massive unemployment among the miners and social consequences are unavoidable that included decrease in local business and economic status of the area, increased alcohol consumption, crime and illegal activities etc. This conceptual model is hypothetical design, used to assess how the change in employment pattern has affected health of individual, economic status and crime rate at the study area, and how this has affected post closure QOL of mining and local communities. Model will also assess how the interruptions in social services provided by company like medical facilities, education facilities etc. has affected the health and education of the miners and local communities after mine closure and in-turn to assess how these interruptions as affected the QOL. Employment change and interruptions of social services have forced miners and locals to displace from the study area. This model will assess how displacement of miners and locals has affected the QOL at the study area. This

model will also assess how the unplanned closure has increased the already existing environmental problems in the area and how this has affected the health of individual which as direct affect on QOL.

4.0. Conclusions

Mine closure has a potential long-lasting impact on mining and local communities in the mining area. The major impact of mine closure like loss of employment, labour migration, discontinued social services and facilities, loss of community cohesiveness and environmental degradation have close relation with quality of life (QOL) of the local and mining communities. Mining activities improve the QOL of the mining and local communities, since it contributes direct and indirect employments, social services, local and national economic developments, but the QOL of mining and local communities may reduce when mining activities cease. Quality of life assessment is a widely used concept currently by common people as well as by governments and local and international organizations. It usually refers to a life which is considered as a good one, well-lived, and being of value. In recent years, QOL assessment has proved to be one of the best instruments towards sustainability.

In the present study the key factors which are directly influenced by unplanned closure of large underground mines are considered. Thus the model is designed to assess how sudden change in employment pattern, shut down of social services provided by company and impacts on surrounding environment are affected other parameters like health, education, crime rate, economic status and displacement of miners and locals. And in the end how all these parameters have affected the QOL of mining and local communities after mine closure.

The results of this study will identify proactive factors that influence the post closure QOL of the mining and local communities in the study areas. It also provide useful information for mine closure planners to minimize the post closure socioeconomic impacts. According to the literature review, the subjective response of the QOL depends on time and varies according to geographical location and physiographical changes, so the present model will be used only to predict the socioeconomic impacts on mining and local communities due to unplanned mine closure of large underground metal mines in southern India.

References

1. Abrams, M. (1977): "Social Indicators and Social Equity." *New Society*, 22, 454-455.
2. Andrews-Speed, P., Guo, M., Bingjia, S. and Chenglin, L. (2005): "Economic Responses to the Closure of Small-Scale Coal Mines in Chongqing, China." *Resources Policy*, 30, 39-54. <http://dx.doi.org/10.1016/j.resourpol.2004.12.002>

3. Azapagic, A. (2004): "Developing a Framework for Sustainable Development Indicators for the Mining and Minerals Industry." *Journal of Cleaner Production*, 12, 639-662. [http://dx.doi.org/10.1016/S0959-6526\(03\)00075-1](http://dx.doi.org/10.1016/S0959-6526(03)00075-1)
4. Bastida, E., Wälde, T. and Warden-Fernández, J. (eds) (2005): "International and Comparative Mineral Law and Policy." *Trends and Prospects, The Hague, Kluwer*, 2005, pp. 627-639.
5. Bowes-Lyon, Jeremy P. R. and McGee, T. M. (2010): "Socio-Economic Impacts of the Nanisivik and Polariss Mines," *Nunavut*, Canada, pp 371-396.
6. Chattopadhyay, S. S. (2001): "Theratholes of Raniganj." *Frontline Magazine*, Vol. 18. <http://www.frontline.in/static/html/fl1824/18240500.htm>
7. Clark, A. L., Clark, J. C. and Naito, K. (1998), "Emerging mineral policy and legislation in the economic development of the Central Asian Republics", *Resources Policy*, Vol. 24, No. 2, pp. 115-123.
8. CSR: Estimating Socio-Economic Impacts of Mine Closure, Research Paper No. 8, The University of Queensland, Australia, undated.
9. Cummins, R. A. (2000): "Personal Income and Subjective Wellbeing: a review." *Journal of Happiness Studies*, 1, 133- 158. <http://dx.doi.org/10.1023/A:1010079728426>
10. David, L. K., et al., (2013): Redevelopment Of A Site With Multiple Issues From Previous Mining, proceedings of 5th International Contaminated Site Remediation Conference, 15-18 September, Melbourne, Victoria, PP. 244-245.
11. Derrett, S., Paul, C. and Morris, J. (1999): "Waiting for Elective Surgery: Effects on Health-Related Quality of Life." *International Journal for Quality in Health Care*, 11, 47-57. <http://dx.doi.org/10.1093/intqhc/11.1.47>
12. Digby (2012): Mine closure through the 21st Century looking glass, proceeding of Mine Closure 2012, Brisbane, Australia, pp. 33-38.
13. Fabian, E. S. (1990): "Quality of Life: A Review of Theory and Practice Implications for Individuals with Long-Term Mental Illness." *Rehabilitation Psychology*, 35, 161-169. <http://dx.doi.org/10.1037/h0079059>
14. Felce, D. (1997): "Defining and Applying the Concept of Quality of Life." *Journal of Intellectual Disability Research*, 41, 126-135. <http://dx.doi.org/10.1111/j.1365-2788.1997.tb00689.x>
15. Felce, D. and Perry, J. (1995): "Quality of Life: Its Definition and Measurement." *Research in Developmental Disabilities*, 16, 51-74. [http://dx.doi.org/10.1016/0891-4222\(94\)00028-8](http://dx.doi.org/10.1016/0891-4222(94)00028-8)
16. Figueroa, B. E. and Calfucura, T. E. (2003): "Growth and Green Income: Evidence from Mining in Chile." *Resources Policy*, 29, 165-173. <http://dx.doi.org/10.1016/j.resourpol.2004.08.003>
17. George, S. D. and Weitz, B. A. (1997): "Comparative Urban Social Indicators: Problem and Prospects." *Policy*

- Sciences*, 8, 423-435.
18. Gill, T. and Feinstein, A. A. (1994): "Critical Appraisal of the Quality-of-Life Measurements." *Journal of American Medical Association*, 272, 619-626. <http://dx.doi.org/10.1001/jama.1994.03520080061045>
 19. Jones, J., Dagnan, D., Trower, P. and Ruddick, L. (1996): "People with Learning Disabilities Living in Community-Based Homes: The Relationship of Quality of Life with Age and Disability." *International Journal of Rehabilitation Research*, 19, 219-227. <http://dx.doi.org/10.1097/00004356-199609000-00003>
 20. Khanna, T. (2000): "Mine Closure and Sustainable Development : Results of the Workshop organised by the World Bank Group Mining Department and Metal Mining Agency of Japan, London," *Mining Journal Books*, 2000.
 21. Laurence, D. (2003): "Mine Closure Risk Modeling – A Continuous Improvement Approach," in Mining and the Environment Conference III, Sudbury, Canada, pp. 1-10, 25-28 May 2003.
 22. Laurence, D. (2006): "Optimisation of the Mine Closure Process," *Journal of Cleaner Production*, vol.14, pp.285-298.
 23. Linda, S. and Robert, G. (2005): "Sustainable Transportation and Quality of Life." *Journal of Transport Geography*, 13, 59-69. <http://dx.doi.org/10.1016/j.jtrangeo.2004.11.003>
 24. Lucrina, S. (2010): "Research on the environmental impact of Some gold mines closure in rosia montana Metallogenetic field," unpublished PhD thesis, Babes-Bolyai University of Cluj-Napoca.
 25. Mariano, Rojas (2010): The Measurement of Quality of Life: Conceptualization Comes First A Four-Qualities-of-Life Conceptual Framework and an Illustration to Latin America, <http://www.iadb.org/res/laresnetwork/files/pr308finaldraft>
 26. Mary, Ackley (2008): Evaluating Environmental Risks In Mining: A Perceptual Study At The Vatukoula Gold Mine In Fiji, Master of Science Thesis, The University of Vermont.
 27. Michael, H. and Maria, S. (2003): "Mine Closure and Its Impact on the Community: Five Years after Mine Closure in Romania, Russia and Ukraine." *World Bank Policy Research Working Paper Series*, 3083.
 28. Michael, K., Monika, K. S. and Wilfried, L. (2005): "Outcome and Quality of Life in Medicine: A Conceptual Framework to Put Quality of Life Research into Practice." *Urologic Oncology Seminars and Original Investigations*, 23, 186-192. <http://dx.doi.org/10.1016/j.urolonc.2005.03.002>
 29. Otto, J. (2009): "Global trends in mine reclamation and closure regulation", J. Richards (Ed.), Mining, Society, and a Sustainable World. Berlin/Heidelberg, Germany: Springer-Verlag.
 30. Pacione, M. (1982): "The Use of Objective and Subjective Measures of Quality of Life in Human Geography." *Progress in Human Geography*, 6, 495-514.
 31. Packer, T., Race, K. E. H. and Hotch, D. F. (1994): "Focus Groups: A Tool for Consumer-Based Program Evaluation in Rehabilitation Agency Settings." *Journal of Rehabilitation*, 60, 30-33.
 32. Patricio, A. (2001): "Impacts and Development in Local Economies Based on Mining: The Case of the Chilean II Region." *Resources Policy*, 27, 119-134. [http://dx.doi.org/10.1016/S0301-4207\(01\)00013-7](http://dx.doi.org/10.1016/S0301-4207(01)00013-7)
 33. Pillalamarry, M. R. and Pathak, K. (2014): "Latent Variable Modeling Approach for Assessing Social Impact of Mine Closure." *Open Journal of Applied Sciences*, 4, 573-587. <http://dx.doi.org/10.4236/ojapps.2014.414057>
 34. PMA (2005): Post-Mining Alliance Concept Note. www.edenproject.com/postmining
 35. Redgwell, C. (1992): "Abandonment and Reclamation Obligations in the United Kingdom." *Journal of Energy and Natural Resources Law*, 10, 59-86.
 36. Robert, W. M. (2003): "Understanding Environmental Quality through Quality of Life Studies: The 2001 DAS and Its Use of Subjective and Objective Indicators." *Landscape and Urban Planning*, 65, 73-83. [http://dx.doi.org/10.1016/S0169-2046\(02\)00239-6](http://dx.doi.org/10.1016/S0169-2046(02)00239-6)
 37. Rogerson, R. J., Findlay, A. M., Morris, A. S. and Coombes, M. G. (1989): "Indicators of Quality of Life: Some Methodological Issues." *Environment and Planning*, 21, 1655-1666. <http://dx.doi.org/10.1068/a211655>
 38. Ryan, Menezes (2006): Improper Mine Closures: Should They Be Considered a Form of 'Displacement'.
 39. Sarkar, S. K. and Sarkar, S. (1996): State of Environmental and Development in Indian Coal Fields: Coal Fields in West Bengal. Oxford & IBH Publishing, New Delhi.
 40. Saxena, N. C. (2008): Mine Closure. Scientific Publishers (India), Jodhpur.
 41. Singh, S. R., (2012): Development of Planning Strategies for Mine Closure with Special reference to ecologically fragile iron ore mines, unpublished PhD thesis, ISM Dhanbad, Feb 2012.
 42. Smith, A. E. (2000): "Quality of Life: A Review." *Education and Aging*, 15, 419-435.
 43. Tankova, T., Galina, D. and Dragomir, K. (2005): "Education and Quality of Life in Diabetic Patients." *Patient Education and Counseling*, 53, 285-290. <http://dx.doi.org/10.1016/j.pec.2003.09.013>
 44. Valérie, Albouy, Pascal, Godefroy and Stéfan, Lollivier (2010): Measuring quality of life, portrait social edition France, 2010. http://www.insee.fr/en/ffc/docs_ffc/ref/FPORSOC10E
 45. Vladimir, P. and Tomislav, S. (2012): "Mines Closure Strategy," *Underground Mining Engineering* 20 (2012), pp. 99-106.
 46. WHO (1997): WHOQOL measuring of quality of life, Division of Mental Health and Prevention of Substance Abuse, World Health Organization.