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Evaluation of Social Externalities in Indian Coal Mining Industry: A Concept

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ABSTRACT
Concept of externality is century old. The action of one consumer or a firm should not affect the well-being of another consumer or a firm with whom there is no direct business relationship. Nevertheless, in reality, our economic activities control natural systems directly or indirectly, and definitely has some externalities. This arises when an individual or a firm takes an action but does not take account of the external cost or benefits that are being generated because of lack of any incentive. In this paper, an attempt has been made to identify the social externalities of coal mining in India.

Keywords: Externality, Social & Environmental Awareness, External Cost, External Benefit, Social Externalities, Coal Mining.

1.0 PREAMBLE

An ***externality*** is a change of state in a process, which is not directly related to that process but to another process as a cause. It is the side effect on an individual or entity due to the actions of another individual or entity. It can be defined as an economic cost or benefit that is the by-product of economic activity but that is allocated outside of the market system. This means that the producer of the externality has no incentive to take account of the external cost or benefits that are being generated.

Ideally speaking, the action of one consumer or a firm should not affect the well-being or production of another consumer or a firm with whom there is no direct business relationship. Nevertheless, in reality, all our economic activities control, direct or modify natural systems directly or indirectly, and definitely has some externalities, however prominent or insignificant they are. This arises when an individual or a firm takes an action but does not take account of the external cost or benefits that are being generated because of lack of any incentive.

Broadly, when an externality is beneficial to society it is taken as positive, whereas if its effects are damaging, it is termed as negative. In general, both types of externalities are found in economic and industrial activities. Obviously, mining, a unique basic industry that inflicts irrecoverable constitutional changes in Mother Earth by extracting non-regenerative resources of fuels, ores and minerals from their natural abode, has several prominent or obscure, instant or lasting external impacts that are not accounted in its production cost.

This is more true for Indian coal mining industry that operates in a wide variety of geo-mining conditions and socioeconomic setups, applying almost all levels of technology (from manual loading with baskets to 25 m3 shovel-170 tonne dumper combination) with mines of daily production ranging from less than 100 t to exceeding 40,000 t. Moreover, though Indian coal mining industry annually produces around 400 million t of coal and stands 3rd in the world, it is not esteemed for its attentiveness to safety, environment, conservation, productivity and economics. As a result, Indian society bears considerable external costs, direct as well as indirect, generated by this industry.

Although the concept of externality is more than a century old, it gained importance only since the brusque rise in social and environmental awareness all over the globe in the last two-and-half decades. Several countries have already estimated the external costs of certain industries, while some of them have adopted definite ways and means to internalise a few of these external costs.

On the other hand, in the developing countries including India little effort has yet been made to appraise the external costs of industrial and economic activities. Energy is the thread sustaining and integrating all life and supporting all economics. The type of energy we use and the method by which we use them are major factors determining how much we use the life support systems for all species on earth. The current dependence on non-renewable fossil fuels is the primary cause of air and water pollution, land disruption and projected global warming. In treating nature as an external consideration to market transactions, benefits accrue and costs accumulate. The time is now ripe to be alert of our actions and to assess the hidden costs that is being recurrently borne by the society and is never accounted in the cost of the produce. One should know the cost of production of coal that actually the people of a nation are paying.

In this paper, an attempt has been made to identify the social externalities of coal mining in India, as well as to outline a befitting approach for their evaluation.

2.0 EVOLUTION OF THE CONCEPT OF EXTERNALITY & METHODS OF EVALUATION

The roots of the concept of externality are in the works of two English political economists of previous generations, namely Alfred Marshall (1842-1924) and Henry Sidgwick (1838-1900). Perhaps Paul Samuelson used the term externality first in his address to the AEA in the early twentieth century, and Francis Bator was the first economist to use the term in a published article in place of the earlier use of "external economies." However, Arthur Cecil Pigou, a British economist noted for his studies in welfare economics, was instrumental in developing the theory of externalities early in the twentieth century. His contribution on the issue of externality was initially introduced through publication of Wealth and Welfare in1912. It may be regarded as an extension of the works by Marshall and Sidgwick. Pigou presented a more comprehensive analysis later in his fundamental work, The Economics of Welfare, published initially in 1920. His theory examines cases where some of the costs or benefits of activities "spill over" onto third parties. He suggested imposition of taxes and subsidies to internalise these externalities.

Lionel Robbins challenged Pigou's analysis in the 1930s. He pointed out that, as utility is not measurable, it is invalid to compare levels of utility between different people, as Pigou’s analysis required. He recommended the Pareto optimality criterion for welfare economics.

In 1956, in his paper on Toward a Reconstruction of Utility and Welfare Economics, Murray Rothbard pointed out that costs are purely subjective and not measurable in monetary terms. When people demonstrate their preferences to exchange, we can say that both parties felt that they would be better off trading goods than not. Since Pigou's solution does not involve voluntary exchange, the numbers arrived at is mere guesswork.

In 1960, Nobel Prize-winner Ronald Coase, in his paper on The Problem of Social Cost, pointed that transaction costs could not be neglected. He demonstrated that as long as property rights are clearly defined, transaction costs are low, and any agreement that is in the mutual benefit of the parties concerned gets made, then those parties could always negotiate a solution that takes into consideration the externalities (i.e., internalises them). George Stigler summarised the resolution of the externality problem in the absence of transaction costs in a 1966 economics textbook in terms of private and social cost, and for the first time called it a 'theorem' (although no definite mathematical version of it has ever been stated or proved). However, the two major limitations of applicability of the Coase Theorem are that [i] transactions costs are not zero in many situations, and [ii] in whatever way one allocates the property right, the distribution of income is affected.

Kapp (1950, 1970) expressed that the knowledge about and extent of environmental impacts had grown to the extent that the word "externality" was no longer appropriate and suggested the term social cost. He defined it as "all those harmful consequences and damages which third persons or the community sustain as a result of the productive process, and for which private entrepreneurs are not easily held accountable". Herman Daly, an academic economist and consultant to the World Bank, argues that externalities are a fundamental economic concept contributing to market failure. Whereas in his paper on Why Externalities Are Not a Case of Market Failure? Brian Simpson argues that the very concept of externalities is flawed and should be discarded.

There are several contradictions and controversies among economists in their views on externality. However, different scholars worked further on the postulates of Pigou, Rothbard and Coase to improve and amend them. Perhaps there are several misapprehensions too. For example, many times the Coase analysis has been criticised for seemingly implying that no government action can ever be justified. Yet, it is striking that the Coase approach, correctly interpreted, would imply exactly the same results that a correctly amended Pigou analysis would advocate.

Nonetheless, in spite of wide differences in all these theories and postulates on externalities it is generally accepted that externalities have serious impact on overall social economics.

Thus, simultaneous attempts have been made since 1970s to evaluate externalities in economic terms. Early attempts to include social and environmental variables by converting them to a financial form failed (Estes, 1976; Abt, 1977; Ernst & Ernst, 1978) as definitions and quantification were unconvincing. Theoretical attempts to model the problematic position of accounting in relation to voluntary non-financial disclosures (Mathews, 1984; Gray, 1990) were partly concerned with attempts to identify, measure and value social or environmental externalities. These methods used a top-down approach.

During the last decade, Tranen (1992) and Krupnick et al (1994) addressed relevant issues, while Palmer et al (1995) illustrated a wide range of social costing regimes and their economic and environmental implications. Special emphasis was given to electricity generation and Hohmeyer (1988), Ottinger et al (1990) and Pearce et al (1992) did some pioneering woks. Although the work of Hohmeyer (1988) and others advanced the debate on externalities research considerably, the style of analysis was too simplistic for adoption for policy analysis. In particular, no account could be taken of the dependence of damage with the location of emission, beyond minor corrections for variation of income during valuation.

Consequently, three projects, namely the U.S. Fuel Cycle Study (Oak Ridge, 1992; Lee, et.al 1995), the New York Electricity Externality Study (Rowe et al, 1995), and the ExternE National Implementation Project (CEC, 1995; Schleisner et al, 1997) were conducted extensively with development of elaborate methodological framework. Main objective of these studies was to establish a consistent accounting framework and to estimate the external costs associated with different electricity generation systems in various locations.

In the paper titled "Differences in Methodologies Used for Externality Assessment", L. Schleisner of Rise National Laboratory, Denmark, compared seven externality studies to show the large differences in results from different studies assessing the same fuel cycle (Table 1). The studies were chosen covering old, well-known studies as well as new, less, known but interesting ones. Some of the new studies were based on results from earlier ones while others implement new ideas concerning the methodology. Most of the studies are bottom-up studies. In the table, the results from the different studies were translated to mECU/kWh year 1995.

Approach	**Fuel cycle**				
	Coal/Oil	**Natural Gas**	**Nuclear**	**Wind**	**Biomass**
ExternalE (Schedule et al, 1997)		NGCC: 7:1 TO 80		Offshore: 07 to 3.6 On-land: 0.6 to 2.6	Biogas: 4.4 to 6.1
IEA (ETSU, 1994)	PC: 0.6 TO 5.4	NGCC: 0.6 TO 2.3 IGCC: 1.6 TO 3.9			
New York (Rowe et al, 1995	PC:45 FB: 0.9	NGCC: 0.2			Wood:3.5
uS-EC (Oak Ridge, 1992)	Coal: 0.4 to 1.0 Oil: 0.1 to 0.2	Coal: 0.01 to 0.2	Coal: 0.1 to 0.2	Wood: 1.6	
India (Bhattacharya, 1997)	Coal: 9.4				
SwIss (Ott, 1997)	Oil: 99.6 to 158	NGCC: 68 to 101	4.8 to 11.5		
Hohmeyer (Hohmeyer, 1988)	Fossil fuels: 7.4 to 40	Fossil fuels: 7.4 to 40	Fossil fuels: 7.8 to 78.3	On-land: 0.1	
PC: Pulverised Coal; FB: Fluidised bed coal; NGCC: Natural gas Combined cycle; IGCC: Integrated gasification combined cycle					

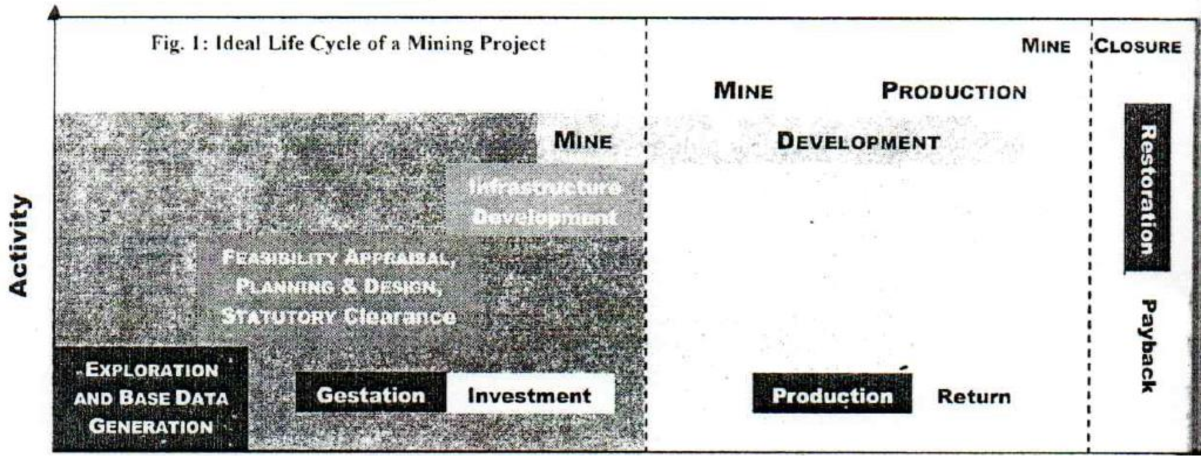
Table 1: 1995 External Costs in mECU/kWh for Different Fuel Cycles

The differences in these values are not only due to the differences in approaches, but also due to differences in sites and choice of parameters. Barring the three projects mentioned above, (ExternE National Implementation Project covered several countries like Denmark, Finland, France, Germany, Ireland, Spain, Sweden & UK), few serious extensive organised studies has so far been conducted at national level that has involved mining industry.

However, in India, where mining is a major industry with a steady rise in production of coal, lignite, iron ore, bauxite, limestone etc., fiscal evaluation of externalities of mining industry in general, and of coal mining industry in particular, is essential not alone for their control and internalisation, but for the formulation of a rational national energy policy as well.

3.0 EXTERNALITIES OF MINING

Alike other productive activities, mining also have positive and negative impacts on society and environment, but unlike them, life of a mine has three stages, [a] Gestation, [b] Production and [c] Restoration. An ideal life cycle of a mining project is shown in Fig. 1.



Time

Fig 1: Life Cycle of a Mining Project

Economic growth is desirable only when it is sustainable and determines human well-being. The entire process of economic activity that a lead to social wellbeing is shown in Fig. 2(a).

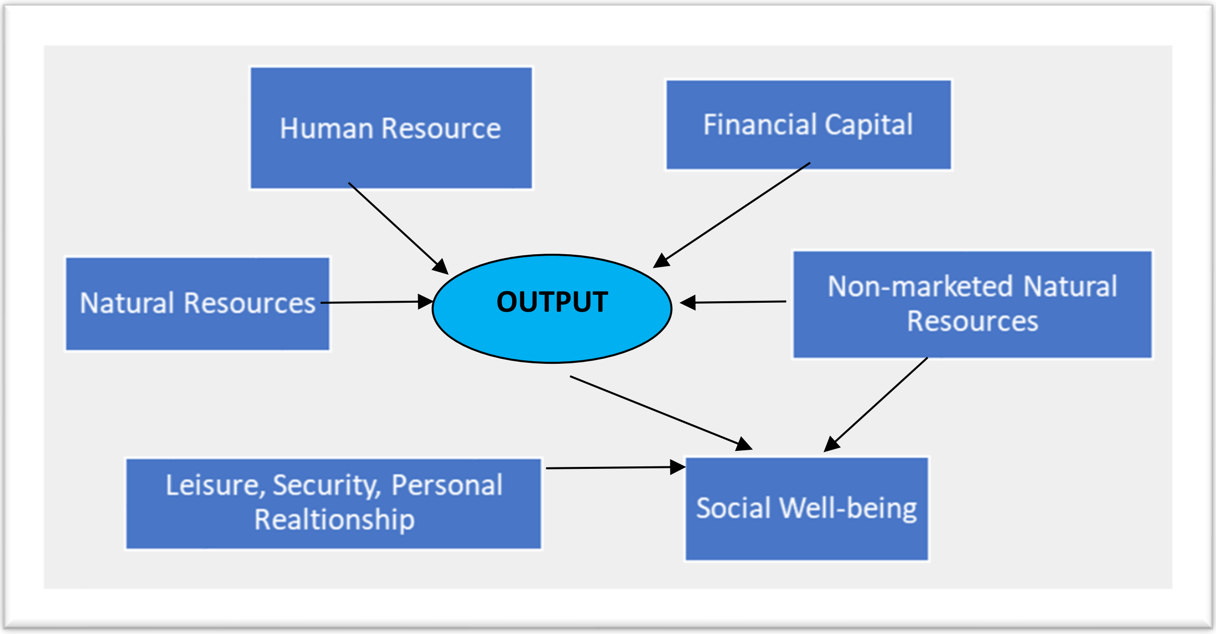


Fig. 2(a): Interrelationship between economic activity and social well-being

Fig. 2(a) gives an ideal situation. However, continuous advance of mining activity changes the above scenario, giving rise to situation as indicated in Fig. 2(b).

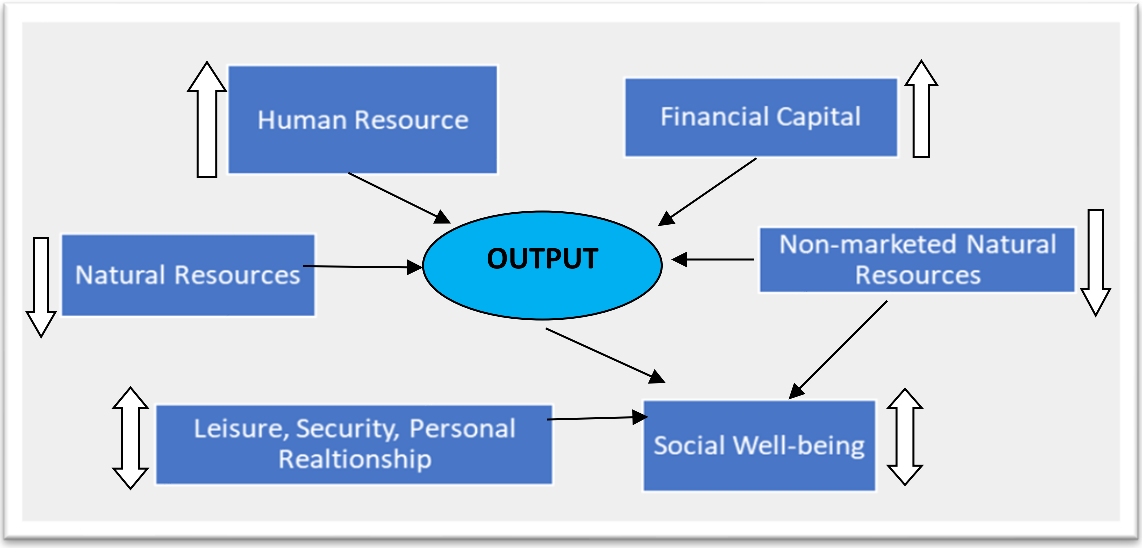


Fig. 2(b): Time-dependent effects of mining on economic activity and social well-being

Growth in mining activity leads to depletion of natural resources and services. On the other hand, there is growth in capital flow as well as human resource. The net social well-being is the ultimate product of various market forces. One such factor affecting well-being is the external costs or externalities.

Alike other productive activities, there are two types of costs associated with mining or indeed with doing of any business. The first type is the familiar ones, which include labour, raw materials, intermediate products and the costs of plant, equipment and capital. These production costs include mitigation costs for managing the environmental and social effects of business. The second types of costs, i.e., the externalities, represent the yet un-priced costs to society of using and sometimes damaging human and environmental resources land, water and air. While industries and individuals do contribute through taxes to the provision and maintenance of some of these external resources, education, health care, environmental protection etc., they are never internalised within a business's operation. These external economics has an impact on the various market forces, which ultimately affects social well-being. In long run, the effect of these net changes on human well-being has an impact on the overall societal development.

Mining industries contribute towards improved social development through providing jobs, paying taxes, building industrial bases, enhancing efficiency, earning foreign exchange and transferring technology. Conversely, they also lead to interference with the sovereign affairs of people by ways of deepening of economic disparities, deterioration of working and living conditions because of corruption, criminal and antisocial activities, pollutions, health and safety hazards, loss of natural appeal of the site, and disrespect of human rights.

The external effects of mining activity on society and environment may be categorised into three spheres: biophysical, economic and social as depicted in Fig. 3.

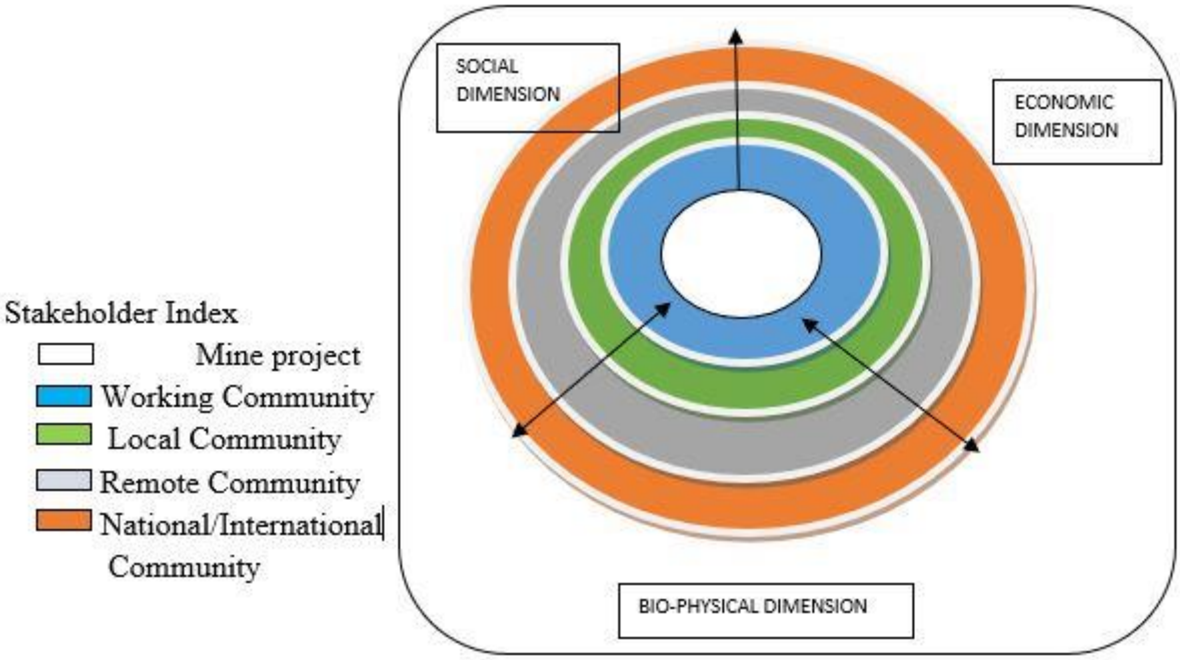


Fig. 3: Effects of Industry on Environment & Social Development

Biophysical sphere includes effects over time on the health of ecosystem, on biodiversity conservation, on clean air and water, and the physical base of healthy livelihoods: marine resources, minerals, forests and agricultural soils.

Economic sphere includes effects over time on relative economic benefits, wages/ salary rates, distribution of natural resource-based commodity rents (taxes, royalties etc.) between central and regional state agencies, and economic effects on local and remote community livelihoods.

Social sphere includes [a] socio-political effects over time on the rights of individuals and groups, and their capacity to organise, [b] effects on human health and working conditions, and [c] socio-cultural effects over time on (i) cultural heritage, (ii) spiritual and cultural well-being, and (iii) attitudes and behaviour of individuals and groups.

In this Model, a mining project is considered as the "input" and the health and well-being of affected stakeholders are "outputs". This model links social, environmental (bio-physical) and economic performance by suggesting that environmentally and socially acceptable production is a part of corporate social responsibility for sustenance of the industry. However, the three dimensions of externalities shown in this model are sometimes so closely interwoven that their boundaries are generally overlapping and fuzzy.

Common and major effects of a mining project on society and natural environment at the different phases of its life cycle have been listed in Table 2.

MINING PHASE	OPERATION	SOCIAL IMPACT	ENVIRONMENTAL IMPACT
PROSPECTING & EXPLORATION	• MAPPING • BOREHOLE DRILLING • ENVIRONMENTAL BASE DATA GENERATION	• ENTHUSIASM & EXPECTATIONS • CONFUSION • HIKE IN LAND PRICE	• DISTURBANCE TO WILD LIFE • GROUND CONTAMINATION DUE TO OIL SPILLAGE

DEVELOPMENT	• EMPLOYMENT • LAND LEASING • CONSTRUCTION • TRANSPORT • COMMUNICATION • RELOCATION • AMENITIES PROVISON	• BOOST IN INCOME • SERVICE PROVISION • POPULATION INCREASE • LOSS OF ARABLE AND HOUSING LAND • RAISE IN TAXES • INCREASE IN SUPPLY AND DEMAND • RISE IN QUALITY OF LIFE	• DEFORESTATION • EFFECTS ON RIVERS, STREAMS & NATURAL DRAINAGE • GROUNDWATER DEPLETION • WASTE PRODUCTION • DISTURBANCE OF RECHARGE ZONE
EXPLOITATION	• EXCAVATION • LOADING • HAULING • GROUND CONTROL • ENVIRONMENT CONTROL • MAINTENANCE	• ACCIDENTS • HEALTH PROBLEMS • DAMAGE TO PROPERTY DUE TO BLAST VIBRATION & GROUND INSTABILITY • SOCIAL DISTURBANCE • DROP IN AGRICULTIRE AND WATER AVAILABILITY	• AIR POLLUTION • WATER POLLUTION • DAMAGE TO WATER TABLE • SOIL EROSION AND CONTAMINATIOIN • SUBSIDENCE • NOISE POLLUTION • CHANGE IN LAND FORM
CLOSURE	• RECLAMATION • DISMANTLING PLANTS & MACHINERY • SALE OF EQUIPMENT • WITHDRAWAL OF SERVICES	• LOSS OG LIVELIHOOD • LOSS OF ARABLE LAND • SOCIAL TENSION • INCREASE IN ANTI-SOCIAL ACTIVITY	• WATER POLLUTION • CONTAMINATED SOIL • CHANGE IN LAND PATTERN

		• DROP IN QUALITY OF LIFE	
BEYOND CLOSURE	• ILLEGAL MINING	• ACCIDENTS • HEALTH PROBLEMS • INCREASED CRIMINAL ACTIVITIES	• SURFACE & GROUNDWATER POLLUTION • SOIL CONTAMINATION • GROUND INSTABILITY

Table 2: Effects of mining on the social and natural environment

Various direct and indirect impacts of a mining project on society over its life cycle. i.e., from inception to closure, have been briefly shown in Fig 4.

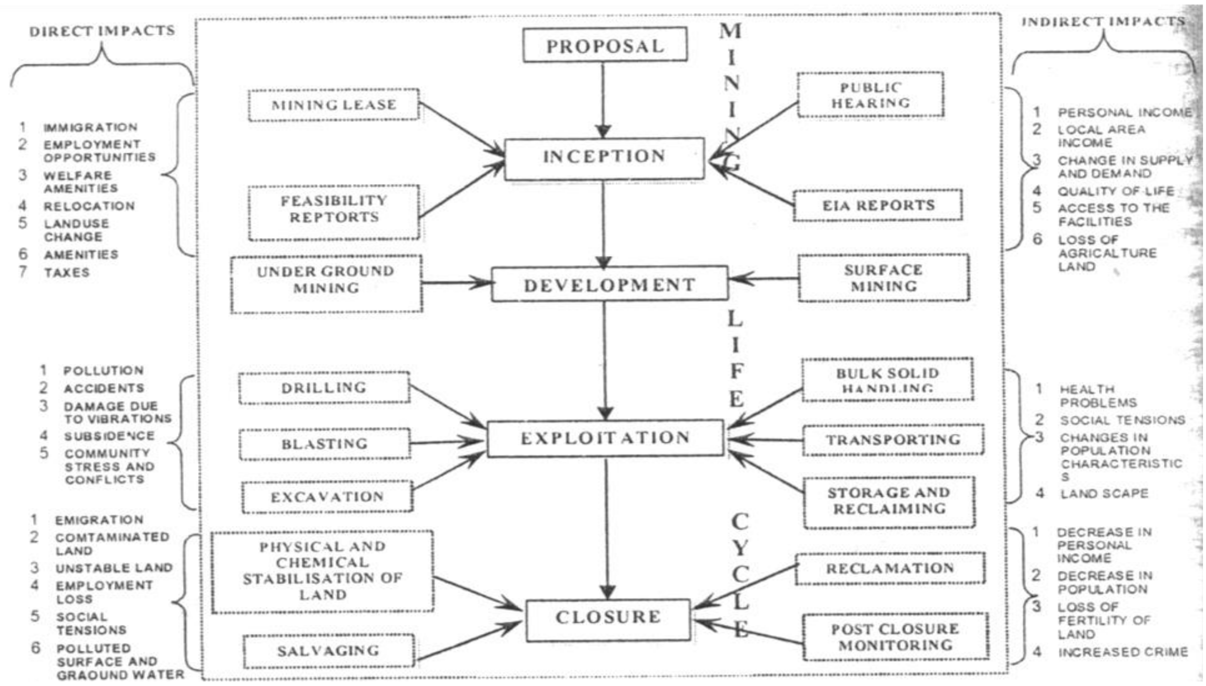


Fig 4: Direct and indirect impacts of a mining project life cycle on society

4.0 SOCIAL EXTERNALITIES OF INDIAN COAL MINING INDUSTRY

Major social both positive and negative and environmental (usually negative) externalities which are commonly experienced in a mining project, have already been depicted in a self- explanatory way in Table 2 and Fig. 4. However, owing to the wide diversity in geo-mining, technological and socio-economic backdrop in which it operates, Indian coal mining industry has a typical external cost-benefit situation that is not likely to find a match in any other part of the world. It is more so with the recent adoption of a controlled open market policy in coal sector by Government of India. Although no scientific and systematic study has so far been conducted in India in this field, one may easily assume at a glance, that due to typically high population density, even the positive externalities or external benefits of Indian coal mining projects would differ in both, magnitude and direction, compared to the findings of systematic studies conducted elsewhere so far.

Social benefits provided by Indian coal mining industry, which leads to its social externalities, may be discussed after identifying the process of development as stated by this industry in an area. In Indian perspective, coal mining usually gets started in areas that are otherwise economically backward, and experiences noticeable infrastructural development along with the growth of the coal mining industry. As a result, assimilation of people from diverse social, cultural and economic backgrounds occurs.

4.1 POSITIVE EXTERNALITIES

Coal mining usually gets started in areas that are otherwise backward in economic growth. with mining activities getting started, the area experiences development of infrastructural facilities, rise in employment opportunities and consequent rise in requirement/demand of the people.

This leads to further growth of economic activities. Markets develop in and around mining areas and show continuous growth. Slowly there is upliftment in general standard of living of the people. Simultaneously, general rise of education level and awareness among people enhance the saving habit of people. In the process, there is overall improvement of *quality of life* (QOL) resulting in *positive externalities* as depicted in Fig.5.

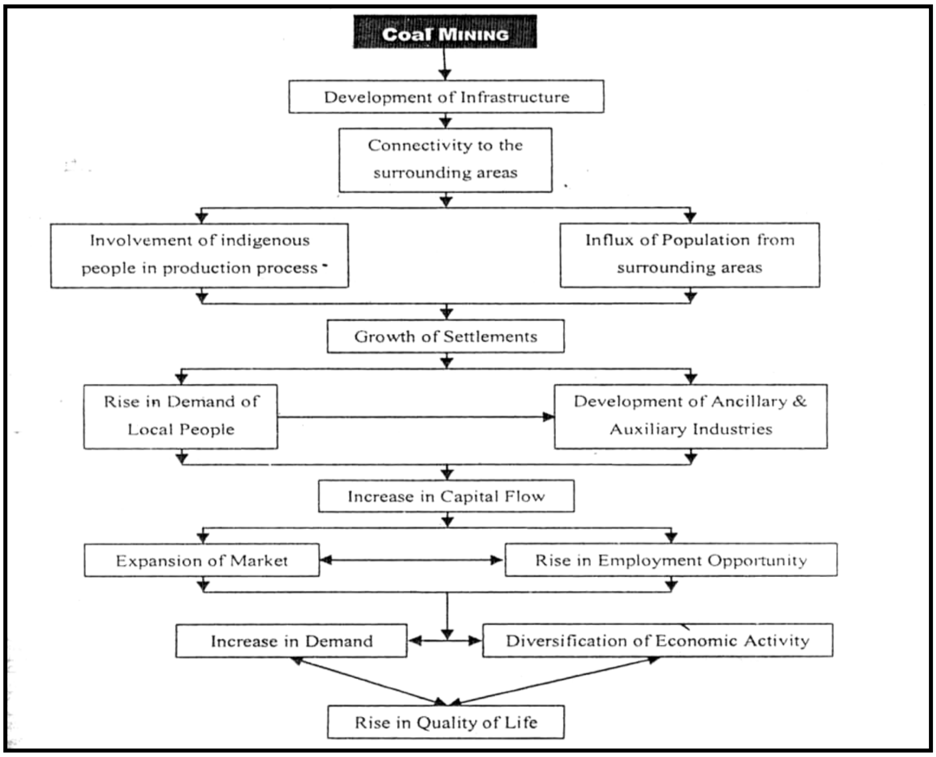


Fig.5: Positive socio-economic externalities due to coal mining industry

4.2 TYPICAL NEGATIVE SOCIAL EXTERNALITIES OF INDIAN COAL MINING INDUSTRY

Coal mining in India is burdened with age-old history of unscientific and irregular mining. Despite nationalisation of this industry in early 1970s, followed by mechanisation of some mines, opening up a number of new mines and phenomenal growth in coal production in this country, at many places in its extensive variety of geo-rnining, technological, socioeconomic settings, scientific and planned approach is still lacking. Although Indian coal mining industry has led to marked societal development, it has certain negative impacts on the society, the responsibility of which is not borne by this industry. Moreover, certain externalities that occur here are the outcome of the typical socio-economic backdrop of the region, the state, or India as a whole. Indian national mineral policy has also some role to play in this respect.

On the other hand, these externalities may affect the society at local, provincial, national, as well as global level. Consequently, the society bears those costs, by design or by default. Currently available level of information and database on the externalities of Indian coal mining industry is too skimpy to conduct any methodical analysis in this field.

However, the first step to evaluate these externalities is obviously to identify and define their causes and effects clearly and categorically. It is very common that one cause leads to multi-faceted effects, whether social or environmental. Nevertheless, certain environmental, especially ecological, effects may not have any perceptible socio-economic consequence, most other biophysical externalities have definite, and generally direct, upshots on society, which, if scrupulously monitored, may be somewhat rationally monetised as well, barring the aesthetic and psychological ones that also play very serious roles in all spheres of a society.

Coal is a fuel and is supplied ultimately for combustion, whether at a thermal power station, or a steel plant, or a lime kiln, or a brick hearth, or a domestic oven, or at any other furnace. A simple pictorial depiction of the processes involved until the delivery of coal at the site of its end use has been presented in Fig. 6.

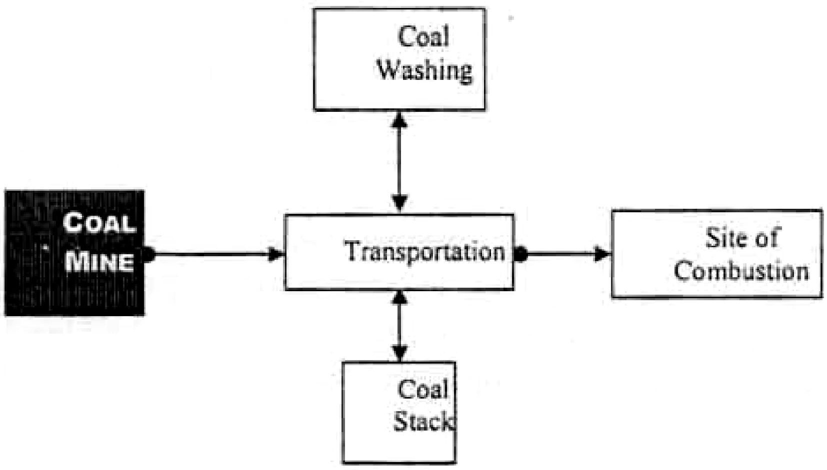


Fig. 6: Coal – from mine to furnace

Being anti-nature by character, any mining operation, irrespective of its geological, technical, geographical or social settings, certainly has some negative impacts on the regional ecology, environment and society. Sometimes these consequences are rapid and obvious, but some are slow and indistinct. Some of these outcomes are inevitable in a given geo-mining and environmental condition, but others may be technically mitigated, if not fully eliminated, and the degree of their control depends the technology adopted. Thus, the costs of these effects are either only partially accounted or totally ignored in the mining cost. As a result, they are borne by the society, whether individually or collectively, may be in short or long runs.

Major negative impacts usually caused by Indian coal mining activities are listed below:

1. Disturbance/damage to natural ecosystem
2. Permanent loss of land, arable/residential/forest/barren, because of:
   - Ground excavation
   - Overburden/waste dump

- Subsidence
- Coal bed fire

3. Change in topography leading to:
   - Disturbance in natural drainage pattern
   - Disturbance of recharge zone
   - Loss of natural beauty
4. Disturbance of groundwater system due to:
   - Lowering of groundwater table
   - Wastage of groundwater/mine water
   - Damage of recharge zone
5. Poor mining performance resulting in:
   - Rise in production cost/loss in business
   - Permanent loss/wastage of in situ coal
   - Mining accidents
   - Coal bed fire
   - Damage due to blast vibration
   - Illegal mining
   - Improper closure
   - Reduction of productive life of mine
   - Loss of ground stability and safety
   - Loss of social security
6. Pollution resulting from coal mining and washing:
   - Solid wastes – dust, waste dump
   - Gases – noxious gases, greenhouse gases
   - Mine acid drainage
   - Noise
7. Poor storage & transportation system bringing about
   - Air pollution
   - Loss of coal due to theft
   - Spontaneous heating & fire
   - Road/rail accidents

The effects of each of these negative upshots of mining on society are different, some can be easily perceived, while some are difficult to realise even over a very long period to come. For example, it is sometimes extremely problematical, if not impracticable to estimate the exact extent of damage of an ecosystem due to a mining activity. From the census of bigger plants and animals in a land prior to mining one may find out how many trees have been felled or how many of major birds or animals have fled or died due to mining. A fiscal valuation of that loss may also be somewhat rationally estimated. However, we ignore the smaller forms of lives that are lost in the process of mining and it is extremely difficult to financially estimate the impact of such losses on society.

If the land is a forest one, this loss is internalised by afforestation in non-forest land of double the size of mine area. Nonetheless, we do not honestly recreate the ecosystem that is lost due to mining, and in many cases, revegetation of non-forest land is done by foreign plant species, and not by the native ones. If it is a private farming or residential land, the mine management buys it through negotiation with landowner/s and little attempt is made to maintain or re-establish the original ecosystem. It is a challenge to researchers, technologists and socio-economists to rationally compute such indirect externalities on the society caused by mining in terms of money.

As a result, though the quality of life of local people goes up with the coming up of a colliery, because of loss of arable and residential lands there is simultaneous hike in land and food price leading to overall rise of cost of living in that area.

Excepting a few types of large, permanent civil constructions like dams, a land used by any other industry other than mining do not lose its ready reusability in some form or the other after the industry is closed, as its stability and safety is not disturbed and in most of the cases there is little change in its original topography. On the other hand, the loss of land caused by coal mining, which exploits non-renewable natural resources and thus is not a truly a site-specifically permanent industry, is often permanent in nature, whether it is due to ground excavation, overburden/waste dump, ground subsidence or coal bed fire. This is due to lack of planned mining operation and proper mitigative measures. Permanent losses of land in this fashion have an impact not only at local or state levels, but also at national as well as global levels. Such losses can be mitigated by systematic mine reclamation and closure.

Until as late as 2003, the term mine closure did not exist in Indian statutes. It was brought into Indian legislation as the Government of India, in the exercise of power conferred by Section 13 of Mines & Minerals (Development & Regulation) Act, 1957, amended Mineral concession Rules, 1960 and Mineral Conservation & Development Rules, 1988, and notified the amendments in the Gazette of India Extraordinary, Part II, Section 3, Sub-section (i), G.S.R. 329(E) & 330(E), on April 10, 2003. Subsequently, on August 08, 2003 the Chief Controller of Mines of India issued a circular (no. 14/2003) on guidelines for mine closure plan.

However, statutorily its application is restricted only to non-coal mines, and no measure has yet been taken to implement similar rules in Indian coal mines. Whereas, inappropriate abandonment of numerous coal mines in this country is the only cause for irrecoverable loss of large areas of land in different coalfields. It is perhaps easier to internalise this externality than to monetize it. Though a part of the cost is evidently, directly and instantly borne by the societies in coal mining areas and their surroundings, a major share of it is inconspicuously borne by the whole country in long run.

Ground excavation and waste dumps deform the topography, change the surface drainage pattern, disturb groundwater recharge zones and damage groundwater tables. In addition, huge wastage of water occurs in Indian coal mines. In Jharia coalfield alone, more than 1.5 million litres of water is pumped out per minute from its mines, of which a trivial amount is recirculated and reused for industrial, agricultural or domestic purpose. In new mines, during planning of management of environment, the issues on waste dump, surface drainage, groundwater recharge zone etc. are addressed to some extent, but in old coal mines, mostly belonging to public sector, all these aspects are grossly disregarded.

With the ominous forecasts and warnings from the scientists and scholars of the expected global shortfall of water in not-so-distant future, this externality cannot be ignored. Nor it can be estimated merely in terms of the immediate rise in pumping and/or supply costs of water in mining and surrounding areas, as it will be grossly irrational from the standpoint of our legacy to future generations.

The externality assessment procedures used so far in the West European countries and the US, as mentioned earlier in this paper, cannot be impeccably fitted in the Indian coal mining industry as its techno-economic situation differs basically from that of its counterparts in those countries. While in India, despite the Government relaxing its control on coal mining for about a decade, the public sector companies predominantly run the industry. In Europe and the US, coal mining is a private business. As a result, profit made by Indian coal mining industry has a positive contribution on the country's development through the enrichment of its coffer. On the other hand, all the taxpaying Indians, regardless of their connection with coal mining industry, effectively share its financial loss.

It cannot be concealed that even after three decades of nationalisation with elaborate trials of modem technologies and rapid rise in production, overall techno-economic performance of Indian coal industry is not satisfactory. Productivity in underground mines, which contributes about 20% of the national production, has shown no sign of improvement in these years. Although some of the coal companies have made profit, a few are economically not so well off. With respect to its quality, the production cost of Indian coal is not low vis-a-vis the global market.

Indian coal mining industry, particularly the underground version of it, is plagued with poor recovery and wasteful mining and improper abandonment of mine workings, which results in different interconnected external effects, like [a] permanent loss of national non-renewable natural resource, [b] coal bed fire, (c] mine accidents, [d) reduction of mine life and thus drop in employment, [e] loss of safety and stability of ground, [f] illegal mining, [g] loss of social security, and (h] permanent loss of land in the long run.

Of these externalities, coal bed fire in turn has a series of social external impacts, of which the major ones are [a] permanent wastage of coal, [b] emission of noxious and greenhouse gases, namely CO and CO2, [c] loss of safety and stability of ground, and [d] permanent loss of land. Some effects are local, some are national and the rest are global as well.

Another externality, not atypical in Indian coal mining industry, is the damage of dwelling due to vibration of blasting in mines. This is perhaps the only externality that is generally rightly internalised, mostly because of opposition of local people, out of their consciousness as well as ignorance. In most of such cases, blast vibration is monitored, and if its level is found to be really damaging to surrounding localities, the damage is compensated through negotiation between the mine management and the affected people. Simultaneously, mine management modifies the blast design to control vibration and avoid recurrence of such troubles.

Coal mines in India are known for accident proneness. This is primarily due to the high manpower-intensiveness of this industry. There are statutory provisions for compensation of mine accident victims. However, there is always a clear impact on the day-to-day life in the surrounding localities in case of occurrence of a mine accident. Obviously, the dimension of the effect depends on the gravity of the accident.

Waste management is often a problem with Indian coal mining industry. Each of the wastes generated has multiple effects on society. For example, dust alone causes [a] morbidity among people in the surroundings, [b] rise in cost of maintenance [c] pollution of surface water, [d] increase in silt load in surface drainage, (e] loss of fertility of farming lands leading to drop in agricultural output, [f) increase in toxicity in air leading to acid rain, [g) reduction in visibility causing road accidents, etc. that leads to certain externalities on society. Likewise, all other solid, liquid and gaseous wastes also have negative impacts on society, which do not need to be elaborated here.

Noise created by the mining industry not only disturbs the ecology of the surroundings but also affect the society causing [a] annoyance and irritation, [b] disturbance in alertness and concentration, [c] disturbance in rest and sleep, [d] disturbance in speech, conversation and communication, and [e] temporary deafness. All these factors lead to reduction of manpower productivity and sometimes accidents as well.

The externalities generated due to low efficiency coal processing and improper transport are also similar, and their effects can be estimated in similar fashion as devised for coal mining.

5.0 INTERNALISING THE MINING EXTERNALITIES

From this discussion, it is clear that the external costs for coal mining technologies may be assessed using different approaches. However, whatever methodology is developed or adopted, it should satisfy the following criteria:

- Transparency, to show precisely how results are calculated, the uncertainty associated with the results and the extent to which the external costs of any mining system have been fully quantified.
- Consistency of methodology, models and assumptions (e.g. system boundaries, exposure- response functions and valuation of risks to life) to allow valid comparisons to be made between different mining systems and different types of impact within a system.
- Comprehensiveness to at least identify all the effects that may give use to significant externalities, even if some of these cannot be quantified in either physical or monetary terms.

These factors are imperative to determine the magnitude of impacts and thus the associated externalities. In view of the vast differences in characteristics of different coal mining fields in India, inclusion of site dependence as the location is important in determining the size of impacts.

Common means suggested for intemalising the externalities by charging to the entity responsible for their generation are by -

- vigorously regulating discharges to force organisations to internalise costs either by purchasing new technology or by paying fines, and/or
- giving permission to discharge under permitted conditions (financial charges, sinking lid allowances), and/or
- charging for non-polluting externalities in the form of services/facilities provided for the use of the organisation.

Incidentally, none of these three approaches indicates that externalities can be determined in financial terms with any precision, even if physical measurements are made, and total discharge is estimated. Indeed, the full cost of externalities would include all the effects and their mitigation and remediation, which would be problematic to calculate.

A method, termed as Environmental Equity Accounting (EEA) by Epstein (1996) and Boone & Rubenstein (1997), was developed for financial measurements of externalities to fit into usual accounting format. Boone & Rubenstein (1997) suggested two approaches.

(1) Cost of Control approach using the cost of installing and operating environmental control technologies as an approximation of the value of the externalities removed. In this approach the highest cost of control under the existing environmental Standard provides an estimate of the price that society is willing to pay for a given level of environmental protection.

(2) In Damage Function approach, environmental and scientific data and modelling are integrated with economic models and methods to calculate external impacts and costs.

Boone & Rubenstein (1997) considered that EEA is a quasi-ownership interest in the wealth of an enterprise that is based on a non-monetary contribution of material, human intellectual, social or natural capital and are essential for the reporting enterprise to remain a going concern. They noted that environmental obligations would not meet the normal definitions or either assets or liabilities. They suggested that the accountants interested in rendering a real accounting of a company might find that there is a need to develop new rules based on all the resources the company consumes (both privately and commonly held). To do this, the accountants may have to recognise that the environment has the same status as any other factor of production, whether it is land, labour or capital.

However, Boone & Rubenstein (1997) did not set out to provide a model to be universally applied. This was because of the parameters that they used in their examples, and the way in which they regarded the process an internally generated and limited, to one organization.

Epstein (1996) observed, "We can consider measuring environmental costs based on the cost to control pollution before it occurs, the cost to clean up pollution after it has occurred or the cost of repairing damage to the environment caused by the pollution……Identifying and measuring external environmental costs is important for the environment……."

Another approach of cost estimation of negative externalities is Dose Response or Impact Assessment. This approach is used primarily to estimate the social cost due to effect of pollution on human health. In this method, the rate of pollution-related morbidity and mortality in the affected population, the cost of treatment and the associated loss of income are estimated by thorough review and statistical analyses of health and medical records from different sources in the affected region in relation with the degree of pollution.

In the report on "Estimation of Environmental Damages from Mining Pollution: The Marinduque Island Mining Accident", a concept framework was given for estimation of environmental and social externalities. The basic concept of this approach was that the assessment of damage involving the release of hazardous substances to the environment follows three basic steps, namely, injury determination, quantification of effects and damage determination (Dunford, 1992). Injury determination links injury to the release; qualification determines in physical terms the reduction in natural resources services; and damage determination involves valuing the injury in monetary terms. This study highlighted different valuation approaches like, Contingent Valuation Method, Travel Cost Method and Hedonic Property Value Method.

Among these, the Contingent Valuation Method was significant. This method calculated how much households are willing to pay to preserve or restore the natural environment. Such valuation is conducted in form of opinion surveys where individual households are asked to respond to questions regarding their willingness to pay for this purpose by curtailing costs on other heads to ensure nullification or total remediation of environmental degradation. This method is used to evaluate the externalities degrading non-saleable or non-marketable natural assets like forests, recreation sites, national parks etc.

This study also adopted some Estimation Methods, like, estimating productivity and income losses estimating foregone non-market use values. While determining the foregone income and productivity, the changes in net income between two time periods, i.e., the year before the disaster and the year of the disaster, were estimated for the affected population. The general procedure for estimating income losses involved the computation of net revenue using productivity and cost data. While estimating the non-market values, recreation, drinking water, health impacts and other household uses were considered in this study.

From the above discussion, it is evident that there can be many approaches of externality analysis and different approaches may lead to different results. Therefore, it is not only necessary to identify the externalities of coal mining industry in India but the selection of an appropriate approach of externality analysis is required which should be site specific.

6.0 CONCLUSION

It is evident that identification of externalities, especially the negative ones on environment and society are difficult, and it is more so in case of mining whose impacts are multifarious. It is more difficult to quantify them, and even far more complicated to estimate their fiscal valuation. Nevertheless, proper identification of externalities and qualitative recognition of their impacts, however complex they be and even if it is not possible to quantify or monetize them, is the first and the foremost important step in externality study.

It may be noted that the types of externalities of any given project, and their monetary impact and costs are the functions of several intricate technical, economic, social, statutory and environmental factors involving level of knowledge, appropriateness of adopted technology, economic sustainability, statutory provisions and their execution, carrying capacity of the given environment, social consciousness etc. Hence, the details of methodology of every externality appraisal study should be designed separately with particular reference to the given technical, economic, social, statutory and environmental backdrops and the problem of economic evaluation of externalities of coal mining industry in India is no exception. Suitable contemporary theories on externalities and the state-of-the-art techniques of their evaluation may be adopted as the basic principles with necessary alterations from case to case.

Conflicts of interest

The authors declare no conflict of interest.

Ethical statement

The authors state that the research was conducted according to ethical standards.

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