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Review

Assessment of environmental impacts by mining activities: A case study from Jhansi open cast mining site - Uttar Pradesh, India

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Abstract

Mining and its allied activities have taken big strikes during the last century contributing significant infrastructure development and raising the living standards of mankind. However, they have also brought in their wake, degeneration and degradation of natural resources, pollution, health risk and socio-ecological instabilities. Bundelkhand region, occupying almost 71818km^2 in the central planes of India, is known for its rich deposits of pyrophyllite, moram, salt peter, granite, diasporas, sand, etc. Currently, there are around 325 active mining sites in Jhansi district alone. Deforestation, dust generation, water, air and noise pollution and resource depletion are common hazards associated with opencast mining widely prevalent in this region. The present paper attempts to reveal the base line environmental quality and socio-economic setting in and around such mining sites with special reference to the effects on the air, water, changes of land use pattern and occupational health effects of mine workers etc. It also attempts to provide a framework for management strategies to improve the environmental conditions in the mining sites and its adjoining environments.

Keywords: Bundelkhand region, health effects, environmental hazards, opencast mining

Introduction

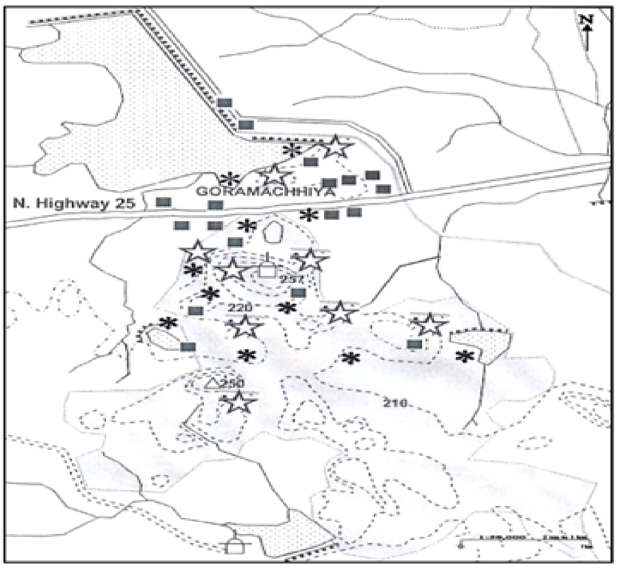
The geographical location of Bundelkhand regions is such that it acted as gateway between north and south India. Administratively, it covers seven district of Uttar Pradesh. Mining and exploitation of mineral resources generally have a considerable impact on the land, water, air, and biological resources as well as socio-economic setting of the local population. Its foci are the environmental issues being confronted by the surface mining industries of Jhansi.The magnitude of impact depends on the methods, scale and concentration of mining activities, and the geological and geomorphological setting (Ghose and Majee 2001). In India the national ambient air quality standard (NAAQS) was formulated in 1994 to assess and compare the air pollution level for different areas (CPCB 1998). Opencast mining, widely prevalent in the Bundelkhand region, though cheaper are known to have more environmental consequences. In opencast mining a massive overburden will have to be removed for the exploitation of the various deposits. This will require excavators, transporters, loaders, conveyor belts etc., resulting into various environmental problems. Environmental impacts of mining operation at individual site may be local phenomena, but numerous mining sites clustered at a particular area may eventually led to environmental problems of larger magnitude. Large scale opencast mining operations in the study area disturb the land by directly removing mine wastes during excavation and concurrently dumping it in adjacent areas. Every mine, big or small, operating or new has to obtain environmental clearance from the Govt. of India (Ghose 1991). Jacko (1983) has given estimates of fugitive dust from some mining operations. Wind blown particulate matters of loose mine spoils and dust generation from crushers and excavation sites may affect ambient air quality in the mine and adjoining areas. Air quality status in Indian environment is dominated by suspended particulate matter (SPM) causing great concern to environmental planners (Ravindra 1991). Noise pollution, especially which due to blasting, might be reduced by strict adherence to noise emission standards (McClean 1992). Water resources are particularly vulnerable to degradation even if drainage is controlled and sediments pollution reduced. Rain and drainage water which may affect the plants, animals and human populations. Groundwater problems may be particularly troublesome in the semi-arid region of Bundelkhand since, water is a scarce resource and people rely groundwater is very difficult and expensive.

Methods

Field surveys were carried out in some selected mine areas (Figure. 1) in Jhansi district to collect relevant information. Data and literature pertaining to the mineral deposits in the region was gathered from various sources. The information related to the status of health and socio-economic impacts were extracted by using structured questionnaires. The respondents include randomly selected mine workers and head of families residing in mine areas. The ambient air quality assessments were carried out in Gora Machiya granite mine area. High volume air samplers (HVS – Envirotech Ltd., New Delhi) were used with an average flow rate between 1.1 – 1.3 m^3 m^{-1}. The air samplers were kept at a height of 6m. Sampling was done for 24 h in 8 h intervals. SPM and RSPM were computed after weighing the glass fibre filter paper (Schleicher and Schüll, Germany) before and after sampling.

Analyses of water quality (APHA 2005) were done by collecting ground water from hand pumps, ponds samples from in and around mining area during pre-monsoon, monsoon and post-monsoon. The hand pumps were operated 10 minutes before collecting the samples. Samples were collected in clean polythene bottles having air tight stoppers. Information pertaining to the health effects of granite mining on the mine workers and the local residents in the nearby villages were survey with the help of a structured Questionnaire. The information collected include, respiratory, eye, hearing loss, skin, accident and others. Various informal interviews with miners, mining officials, government officials, and local community members (around the source of air pollution) were conducted during the study period.

Figure 1. Showing the study area with sampling station
SW (Surface Water)★ Air sampling stations * GW (Ground Water)



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Result and Discussion

Mining in Bundelkhand region are mainly carried out by opencast extraction method. Open cast mining involves the removal of overburden including the valuable topsoil and plus the natural vegetative cover to meet the ore deposits. These activities are associated with harmful effects to the local environment. Mining activities are carried out in various stages, each of them involving specific environmental impacts. Broadly speaking, these stages are: deposit prospecting and exploration, mine development and preparation, mine exploitation, and treatment of the minerals obtained at the respective installations with the aim of obtaining marketable products.The emerging environmental hazards associated with open cast mining practices are many but the major problems may be summarized as follows:

Air pollution

Opencast mining operation creates enormous quantity of dust of various sizes which passes into transportation and disperse significant amount of suspended particulate matters (SPM) and gaseous pollutants in to the atmosphere. These pollutants not only affect the mine workers but also affect the nearby populations, agricultural crops and livestock. During the field study it has been observe that RSPM and SPM is the major source of emission from opencast granite mining in Jhansi. The minimum and maximum value of RSPM and SPM is 155μg m^{-3} to 234μg $m^{-3;}$ and 393μg m^{-3} to 541μg m^{-3} respectively. The extent of harmful affects depends largely on meteorological conditions prevailing in the region. Depending on the size suspended particulate matter may cause (a) Respiratory disorder in animals and human due to inhalation of fine particles, (b) Ophthalmic disease, as particulates act as carrier of pathogens, (c) Lower agricultural yields due to obstruction of light needed for photosynthesis by the dust cover on surface layer of plants, and (d) Poor visibility near crusher.

The variation of SPM and RSPM in the four sampling stations for the month of October to December is depicted separately in Figure 2 – 4. In general the SPM load in all the sampling stations was more than the RSPM concentration and this is as per expectation.

Figure 2. Showing the concentration of RSPM and SPM during the month of October 2009

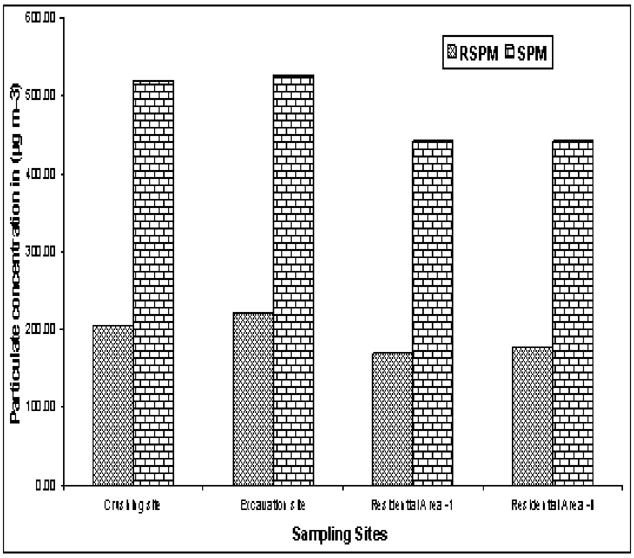


Figure 3. Showing the concentration of RSPM and SPM during the month of November 2009

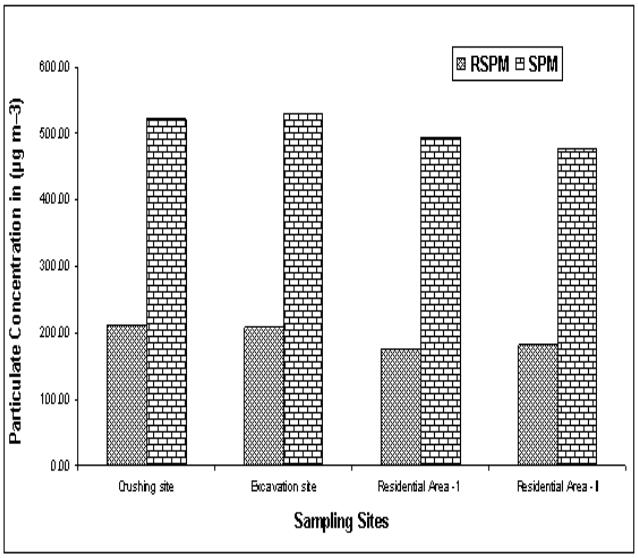
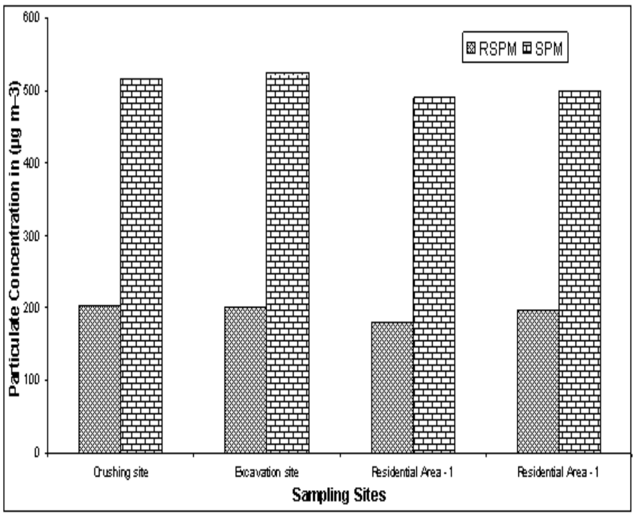


Figure 4. Showing the concentration of RSPM and SPM during the month of December 2009



Water pollution

Mining activities are known to affect both the surface and groundwater regime. The local topography and drainage pattern may considerably influence the severity of pollution. The main sources of liquid effluents in opencast mining are: (a) De-watering of mine water, (b) Spent water from dust extraction and dust suppressing system and (c) Leachate run off from waste dumps. The water composition of the mine water primarily depends upon the host rock composition as well as the mineralization process. Generally, sulfides containing minerals yield acidic mine water whereas in mineral bearing oxides, the pH of the water may go up to 8.0. pH of the mine water of the area was alkaline in nature (7.6–8.5) and conductivity varied between 372 and 1642 µS cm^{-1} (Table – 1). The average conductivity (1,009 µS cm^{-1}) and TDS (839 mg l^{-1}) values for mine water are higher as compared to the groundwater (864 µS cm^{-1} and 669 mg l^{-1}) and surface water (411 µS cm^{-1} and 303 mg l^{-1}). Due to excessive soil and other structural erosion the runoff water contains high amount of suspended solids. These decrease the penetration of light in water bodies receiving the runoff water affecting the survival of living organisms. The leachate water can be extremely toxic containing heavy metals depending on the overburden composition and may pollute the ground water.

Table 1. Physico-Chemical Properties of Ground water and Surface water in and around mining areas of Goramachiya village during 2009 (values are in mgL-1 except pH and EC)

	Pre-Monsoon		Monsoon		Post-Monsoon	
S.No.	GW	SW	GW	SW	GW	SW
	Average	Average	Average	Average	Average	Average
DO	1.74 ± 0.376	2.89 ± 0.130	1.80 ± 0.084	2.02 ± 0.070	2.16 ± 0.086	3.11 ± 0.058
BOD	1.53±0.028	2.63±0.0808	1.65±0.609	1.86±0.028	1.9 ± 0.043	2.93±0.110
pH	7.06 ± 0.036	7.3 ± 0.047	7.15 ± 0.031	7.2 ± 0.038	7.20 ± 0.023	7.4 ± 0.035
EC (µS/cm)	935.1 ± 0.075	378.9 ±0.067	637.9 ± 0.038	326 ± 0.044	460.6± 0.079	539.9 ±0.058
Alkalinity	92.8 ± 0.062	57.3 ± 0.118	76.8 ± 0.148	57.5 ± 0.194	85.8 ± 0.065	71.3 ± 0.275
Ca++	254.3 ± 0.054	121.0 ±0.084	126.8±0.064	109.3 ±0.099	195.3 ±0.062	102 ± .0.060
Mg++	112.8 ± 0.058	120.9 ±0.085	153.9 ± 0.034	50.8 ± 0.383	250.1 ±0.080	111.9 ±0.070
TDS	342.2 ± 0.057	241.6 ±0.053	519 ± 0.028	203.8 ±0.035	515.6 ±0.043	516.7 ±0.042

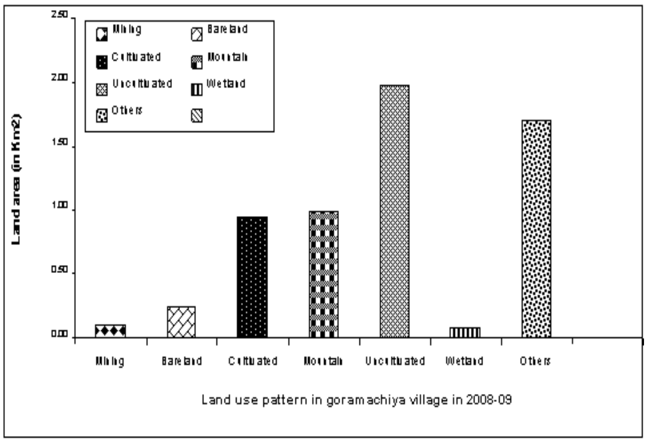
Noise pollution

In open cast mining blasting is a common practice which produces high intensity of noise. Deafness is brought about by slow but progressive degeneration of neuro-sensorial cells of the inner ear. Besides, noisy working environment in the mining sites are known to result into communication impairments, task interference, sleep interference, change in personal behavior, etc. of the mine workers. In addition, noise produces other health effects, influences work performance and makes communications more difficult. Besides, the fauna in the forests and other areas surrounding the mines/industrial complexes is also effected by noise and it has generally been believed that wildlife is more sensitive to noise and vibrations than the human beings.The noise level is comparatively high in the active zones in the granite quarries due to drilling, blasting and the mine service stations. It was found to be in the range of 96 to 125 dB. These are much above the limits of 75 dB prescribed by WHO for day time industrial areas (WHO 1980). In the granite quarries the exposure for long periods to these high levels of noise is likely to affect the ear diaphragms of the workers. Instantaneous loudness from blasting can reach 100 dB and vibrations can be felt up to 2 km distant. At 10 metres, the noise from excavators, spreaders, conveyor belts and their driving stations all may attain 85-95 dB. Even at 1,000 metres noise sources of 75 dB create loudness levels as great as 49 dB (UNECE 1988).

Land degradation

Opencast mining excavates large land areas to extract the mineral ore and at the same time requires huge areas to dump the mine spoils. During this course of action often lands under the cover of forest or agriculture are diverted for mining. Some important impacts on the lands due to opencast mining may be: (a) Change in topography resulting in drastic change in drainage pattern and reduction in aesthetic value, (b) Slope stability problems triggering lands slides and rapid soil erosion, (c) Rapid siltation and degradation of surface water bodies and (d) Blanketing mine spoils in the nearby agricultural and grazing lands. A change of land use pattern in Goramachiya village has been shown in figure 5.

Figure 5. Showing the Land use pattern in Study area



Improper disposal of mine-wastes

Dumping 0f mine wastes without proper location of will cause adverse impact on environment. This depends on the type of mineral, the method of mining and nature of topography around the mines. Actually in course of mining materials is far more than mineral of economic value, which is utilized. The rest is disposed at mine site. The rejected materials may be the overburden, inter burden, side burden, on the tailing rejected after beneficiation. This material is physically, chemically and structurally unstable and is to be dumped on the adjoining land area, add to be the deleterious impact prone to subsistence chemically as well as hydrological unstable for plant growth as it carried for with water streams and degraded environment on the land in vicinity.

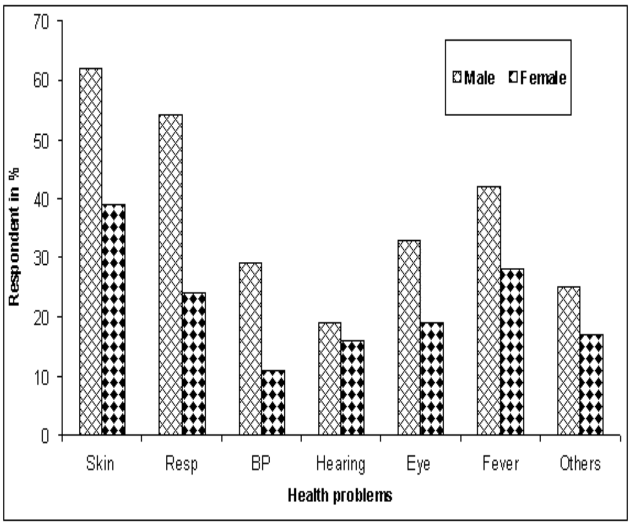
Loss of biodiversity

One major crisis of the present day in Bundelkhand region is the rapid loss of biodiversity. Large scale operations of mining activities have contributed directly or indirectly to the depletion of the biological diversity in the region. Vegetative covers are open up at various places to expedite excavation of ore, development of mining infrastructure and dumping of overburdens. Removal of vegetative cover is often followed by massive soil erosion, siltation of river and reservoirs. The direct impacts on the living organisms in the mining areas may range from death of plants and animals due to mining activity or contact with toxic wastes and mine drainages, disturbance of wildlife habitat due to blasting and heavy machines. Indirect impacts may include changes in nutrient cycling, disruption of food chain and instability of ecosystem.

Occupational human health problems

Opencast mining is more severe an air pollution problem in comparison to underground mining. In active mining sites, miners are persistently exposed to large concentrations of dust, gaseous pollutants, high levels of noise and last but not the least accidents, which constantly pose a severe threat to miner's life. The data on various health effects obtained from the current survey for the mine workers and the population inhabiting in and around the granite mining site is illustrated in Figure – 6. Health problems related to skin and respiratory disorder are widely prevalent in the area. Maximum of the respondents complain problems related to skin and respiratory diseases. A total of 108 respondents have skin problems which comprises of 74 men and 35 women. The digging, blasting and drilling of granite mine generated dust particles of various sizes into the immediate atmosphere. Crystalline silica is a common but variable component of granite. Most of this dust is usually made up of silica (occurring as silicon dioxide SiO_2). As the mining is increasing, workers exploitation is also increasing. Workers are facing serious problems of their health, livelihoods, and minimum wages. The most prevalent occupational diseases among the mine workers in Bundelkhand are: (a) Hearing problems: Effect of heavy noise from use of heavy machineries and rock blasting cause auditory effect as well as non-auditory effects in mine workers and surrounding people, (b) Auditory impact: Auditory effect of noise causes impairing of hearing, (c) Non-Auditory impacts: These type of effect cause loss of working efficiency due to the physiological disorders like hypertension, cardiovascular disease and so on, (d) respiratory problems: Mineral dust particles originating from mining activities on inhalation by lungs and thereby causing a number of concerned problems like silicosis. These diseases are common in Goramachiya and Dagara village of Jhansi. (e) Eye problem: Dust particle from mining activities contribute to cause of certain eye problem like conjunctivitis and kerato conjunctivitis and (f) Skin problem: Deposition of dust particles on skin interrupts U.V. radiation, which causes different skin diseases.

Figure 6. Showing the Health impact of human being in and around Goramachiya Mining area



Remedial Measures

An environmental management plan (EMP) for sustainable mining activities

India, however, is not a unique case, as it is a well known fact that most mining adversely impacts on the environment. It is mandatory to draft an environmental management plan (EMP) before commencing such projects in India. Several countries have adopted different strategies for tackling pressing environmental problems in the industry. For effective implementation of an EMP, a mid-term corrective measure is essential, such as a time bound action plan, this includes a programmed for land reclamation, afforestation, mine water treatment, surface drainage and check dams, and sewage treatment. Development has environmental costs. Therefore, the role of the law is to see how and where to absorb these costs to keep damages at a minimum. The responsibility to improve environmental management rests with the Project Officer of the project. As far as air, water, noise and soil pollution control measures are concerned; samples are collected and tested at strategic locations during all four seasons. The implementing authority is guided and advised as per the data received from the laboratories.

Environmental impact assessment

Environmental Impact Assessment (EIA) is one of the proven management tools for integrating environmental concerns in development process and for improved decision making. As EIA and EMP have been made statutory requirements for starting new mining ventures as well as for existing mines, (at the time of renewal of mining plans) measures to prevent environmental degradation have become a subject of priority with the mine managements. In the initial years, environmental clearance was only an administrative requirement. Since 1994, EIA and environmental clearance have been made statutory for 30 categories of developmental activities in the sectors of industry, thermal power, mining, river-valley infrastructure and nuclear power.

The minerals reserves in the Bundelkhand region are varied and huge in quantities, it is expected that the mining activities may be intensified in future further deteriorating the environmental quality. Proper environmental impact assessment and some times a socio-economic impact assessment should be carried out. Baseline data should be effectively incorporated in management of the mining sites in Bundelkhand region. For proposed mining projects, it is necessary to address the potential environmental impact issues that may arise due to proposed mining activities i.e. an assessment of the potential impacts of a project on the pre-mining environment. The plans required for the EIA must be at appropriate scales to show the level of detail required for the particular project or aspect described. The economic growth and development of the country depends not only on resource optimisation but also on environment management. This aspect of industrialization was not envisaged by planners in the past.

Afforestation

Afforestation practices help in restoring and enhancing the vegetative cover in mine areas in various ways. For reclamation through Afforestation following inventories are the prerequisites such as area to be planted, slope gradient, quality of soil, climate conditions and nature of biotic pressure. For plantation priority must be given to native species in the following order, mining sites, overburden sites and abandoned sites. Those species have to be selected having fast growing tendency to enable to maximum canopy in short time as well as hard woody and ability to fix direct atmospheric nitrogen.

Conclusion

Mining activities are unsustainable not only because they exploit non-renewable resources, but also because they leave behind them destruction of the environment and society, which is very often irreversible. Because of its impacts, mining is one of those activities that need to be strictly controlled at all stages, from prospection and exploitation to transportation, processing and consumption. After abandoned of mines, there is no proper closure of mines; waste dumps will be there, no rehabilitation of the area, no compensation for the labours. There will be always question of that whether land will be given back to the landholder or not. It has been suggested that after closure of mine lands should be given to the landholders, after proper rehabilitation of land. Then they can start to earn his livelihood from the cultivating their own land. Environmental quality must be sustained in areas affected by surface mining. This requires designing and developing environmentally sensitive strategies for extraction and land reclamation. It demands a more rigorous control of environmental impact assessment and more attention to ensuring productive and sustainable land restoration.
Mine rejected granite waste stone materials should be distributed to the local people who are inhabitant the satellite village and also initiate for the manufacture of brick in house purposes and roads. Filter masks should be provided to the workers and plants crushers and mine areas.

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