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Study of Impact of Coal Mines on Environment in Madhya Pradesh

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Abstract: The Sohagpur coalfield is a remnant of the Son valley basin of Gondwana deposition and can be subdivided into three major sub basins from west to east: Rungta-Amlai, Kotma, and Bijuri. Thick coal seams occur in the Barakar Formation (Lower Permian) and are being worked extensively. In this paper, we have studied various researches and studies on the impact of coal mines. First, we have collected the papers which were useful to our requirement of studies. Then we collected data related to coal mines in Madhya Pradesh. We have chosen our study area as sohagpur coal fields in which Sharda block was specified for all the readings. After analyzing every assessment on coal mine we came to the point that groundwater running across mines is most affected by mining activities. Deforestation, air quality is also getting effected by mining activities. There were lots of studies based on ground water contamination in coal mines. We have briefed in our paper about that analysis.

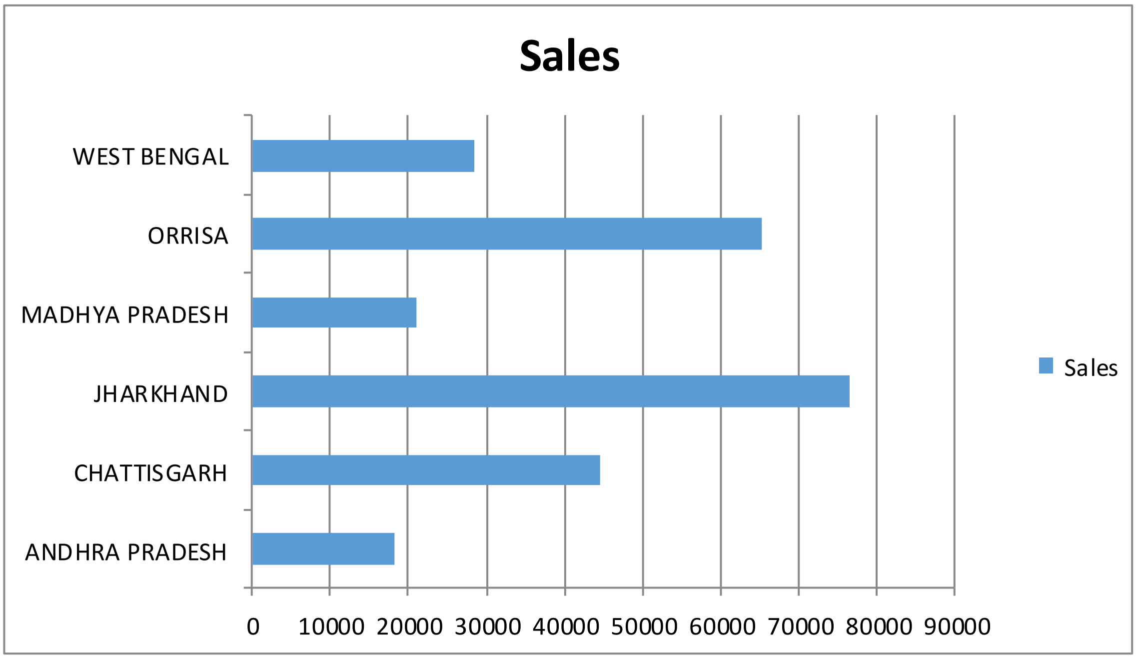
Keywords: Coal Mines, Assessment, Mining, Deforestation, Ground Water.

I. INTRODUCTION

Mineral plays an important role in the economic development of the country as the mineral is the basic raw materials to promote the growth. The development and extent of judicious utilization of minerals resources add to the index of growth of a nation and its people. The mineral industry in India is reckoned not only as an important contributor to the country's GDP and foreign trade, it is also one of the major industries that absorb a considerable amount of the country's working population. This industry is spread almost all over the Indian Territory and has operations in some of the remotest areas of the country, where it can claim itself to be the sole leader of infrastructure development. The mining leases occupying about 0.7 million hectares which is 0.21 percent of the total land mass of the country. This industry operates more than 2729 mines which consist of 570 coal mines, 2300 metalliferrous mines and a source of small mines. India produces 86 minerals out of which 04 are fuel minerals, 10 metallics, and 46 non-metallic and 23 minor minerals. The Indian economy to a great extent depends on the value of the minerals produced, as these represent a major portion of the materials for the nation's industrial activities. India has immense natural resources and is ranked among top 10 globally for deposits in iron ore at 206 million tons, coal 491 million tons and bauxite ore at 23084 thousand tons, which constitute 10 %, 7.7 %, and 10.8% respectively of the world's resources.

With the advent of Independence, the country embarked upon the 5-year development plans. At the beginning of the 1st Plan, annual production went up to 33 MT and during the 1st Plan period itself, the need for increasing coal production efficiently by the systematic and scientific development of the coal industry was being felt. Setting up of the National Coal Development Corporation (NCDC), a Government of India Undertaking in 1956 with the collieries owned by the railways as its nucleus was the first major step towards the planned development of Indian Coal Industry. Along with the Singareni Collieries Company Ltd. (SCCL) which was already in operation since 1945 and which became a Government company under the control of Government of Andhra Pradesh in 1956, India thus had two Government coal companies in the fifties. SCCL is now a joint undertaking of Government of Andhra Pradesh and Government of India sharing its equity in 51:49 ratios.

India with 2.7 per cent of the world reserves ranks sixth in the world in coal resources occurring in Gondwana and tertiary formations. The coal resources of India are available in sedimentary rocks of older Gondwana Formations of peninsular India and younger Tertiary formations of north-eastern/ northern hilly region. Based on the results of Regional/ Promotional Exploration, where the boreholes are normally placed 1-2 Km apart, the resources are classified into Indicated or Inferred category. Subsequent Detailed Exploration in selected blocks, where boreholes are less than 400 meters apart, upgrades the resources into more reliable 'Proved' category. The Formation-wise and Category-wise coal resources (in MT) of India as on 1.4.2009 are presented. As a result of exploration carried out up to the depth of 1200m by the GSI, CMPDI and MECL etc, a cumulative total of 267.21 Billion tonnes of Geological Resources of Coal have so far been estimated in the country as on 1.4.2009. The state-wise distribution of coal resources (in MT) and its categorisation are as follows:



II. METHODOLOGY

STUDY AREA

The Sohagpur Coalfield is the major coal producing area of South Rewa Gondwana Basin and occupies an east–trending rectangular area in the west–central part of the basin. The coal bearing area lies between latitudes 23°05'−23°30' and longitudes 81°13'−82°12' (Fig. 1) and is situated in the Shahdol District, Madhya Pradesh (Raja Rao, 1983). The Barakar Formation is the only coal bearing formation in the coalfield. The coal is being exploited by South Eastern Coalfields Limited (SECL− a subsidiary of Coal India Limited). On the basis of occurrence of coal, the coalfield is divided mainly into three sub basins− Jhagrakhand–Bijuri, Kotma, and Burhar–Amlai. The present study area–the Sharda Open Cast Mine (OCM)–is a part of the Burhar–Amlai sub basin. The Sohagpur Coalfield comprises over 1,000 m thick sedimentary strata. The Gondwana sedimentary rocks in the area strike WNW–ESE to E–W and dip up to 5° towards the north (Pareek, 1987). The Talchir sediments (early Permian) consist of shale, siltstone, and boulder beds and unconformably overlie the basement rocks. The overlying 450 m thick Barakar Formation (early Permian) is composed of sandstones with bands of shale, carbonaceous shale, and coal seams. This coal bearing formation is subdivided into three members lower, middle and upper. The lower member conformably overlies the Talchir Formation and includes a greyish–white feldspathic garnet sandstone, siltstone, and shale, and is devoid of coal seams. The middle member has the maximum thickness and contains cross–bedded feldspathic sandstones with garnet, and thick workable coal seams in the lower portion. The upper member includes ferruginous sandstones, shales, and siltstones. The Pali Formation (late Permian/early Triassic), which overlies the Barakar Formation, is approximately 350 m thick. The Parsora Formation (early Jurassic) is found in the northern part of the basin and includes coarse–grained to pebbly ferruginous sandstones and shales. The overlying Lameta beds (late Cretaceous) contain greenish and reddish, poorly consolidated sandstones and shales with nodular limestone at the top. These beds are separated from the Parsora Formation by a marked unconformity. The coalfield is intruded by dykes and sills (Deccan Trap–late Cretaceous–Eocene). Dolerites are also emplaced along the faults (Dhanam *et al.*, 2013).

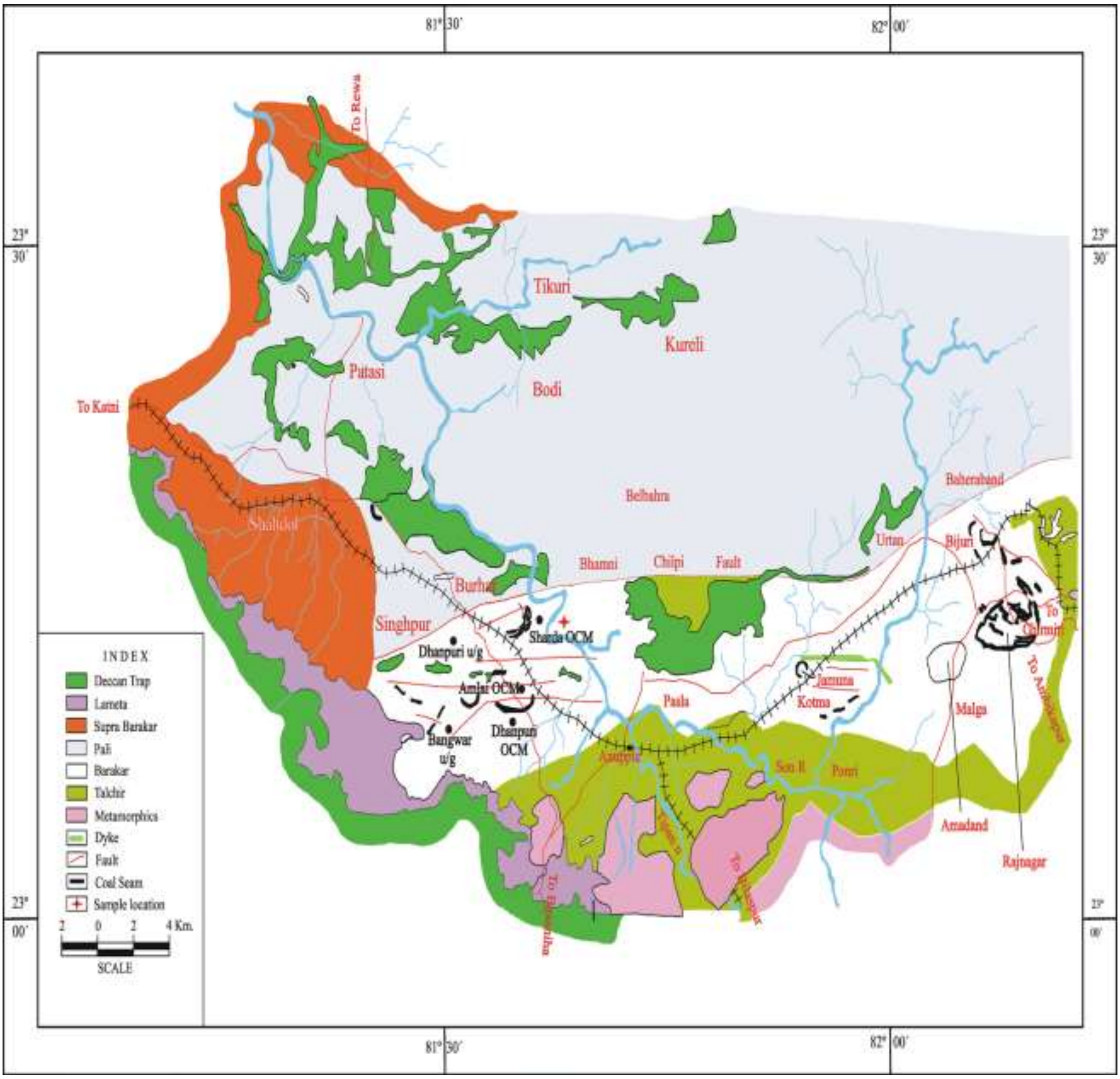
The Sharda Open Cast Mine is located in the eastern part of the Burhar–Amlai sub basin of the Sohagpur Coalfield and was started in the year 1986. The area has a gently undulating terrain with elevations ranging from 450 to 480 m above the Mean Sea Level. The mine is situated in 6 km east of the Burhar Town in the Sohagpur area and lies approximately between latitudes

23°12'10"−23°13'45" and longitudes 81°35'12"−81°38'08" (Fig. 1). In the Sharda Open Cast Mine, 0.85 million tons of coal is being exploited per annum by high wall mining technique.

Data collection and Analysis:

Data for the study were obtained from both primary and secondary sources. Primary data were obtained using a combination of methods, including interviews, questionnaire study, self-observations, samplings, experimentation and informal and formal surveys. Frequencies, percentages, the mean and standard deviation was calculated after feeding the data into suitable software (ezANOVA software) to derive the required relation between different parameters.

Air Sampling: In order to assess the effect of the mining activities on the ambient air quality, air sampling was carriedout for two months, once after ten days, both in the mining area as well as in the local residential area. Handy air samplerMODEL PEM PGS1B was used for the sampling of gaseous pollutants like SOx and NOx and the suspended particulate matter (SPM). The air



sampling was carried out for six hours by running the air sampler in the sampling area during the peak hours. A total of six air samplings were carried out both in the mining area as well as in the nearest residential area. After the sampling, the samples were brought into the laboratory for further chemical analysis. The oxides of sulphur (SOx) in the ambient air were assessed by USEPA

Water sampling: Mining activities have a drastic and profound effect on the water quality. The mining activities in the mining area have exposed the ground water which is being polluted by the pollutants released from the mining activities. In order to assess the effect of the mining activities on various parameters of the ground water quality, water sampling was carried out. Two sites were selected in the mining area where extensive pit mining has exposed the underground water. The sites, site 1 and site 2 designated as S1 and S2 respectively were selected in the mining area. A third sampling site was chosen, which is a tube well located about half a kilometre away from the mining area. The samples from this tube well were regarded as control (C). Collection and sample handling were conducted in accordance with the standard methodology for the sampling and analysis of the analyzed parameters. Two water samplings were carried out at a gap of one month. The samples were collected and brought in the laboratory for rigorous water quality estimation. The chemicals used in the water quality analysis were of GR/AR grade. Standard methods of American Public Health Association (APHA 20th edition) were used for the analysis of water samples7. The sampling locations were chosen carefully so as to assess the effect of mining on the ground water quality. The description of the sampling sites is given in table 1

Sample code	Place of sample collection
SITE 1	Ground water exposed by intensive pit mining
SITE 2	Ground water exposed by intensive pit mining at second place
Control	Water sample collected from a tube well (boring) about half a Km away from the mining area

III.RESULTS AND DISCUSSION

A total of 18 water samples were collected and subjected to analysis to assess the effect of mining activities on the water quality. The observed values of various water quality parameters were compared with the BIS (Bureau of Indian Standards) standards to assess the effect of the mining on the water quality. The values of the analyzed Physico-chemical parameters of water are given in table 2.

Table-2
Effect of mining activities on the physico-chemical parameters of water from different sites

Different physicochemical parameters of water	Units	First sampling			Second sampling			BIS standards for drinking water
		Site 1	Site 1	Site 1	Site 1	Site 1	Site 1	
.pH		7.21	7.28	7.51	7.31	7.34	7.67	6.5-8.5
Conductivity	µmhos/cm^2	842	844	224	840	850	228	600
Turbidity	NTU	15	17	8	15.1	16	8	5
TDS	mg/l	1.97	2.01	0.57	1.99	2.05	0.61	0.50
Total Alkalinity	mg/l	300	315	552	299	317	561	200
Free CO2	mg/l	26.4	27.8	40.92	26.8	26.9	41.03	60
Total Hardness	mg/l	712	716	148	713	715	149	300
Chloride	mg/l	99.4	100.9	142	100	101.6	146	250
Fluoride	mg/l	1.5	1.9	1.3	1.6	2.1	1.21	1.5
DO	mg/l	4.1	4.9	5.2	4.3	4.6	4.9	5.0-6.0
BOD	mg/l	19	19.3	6	19.1	19	6	2-3

Hydrogen ion concentration (pH): pH indicates the intensity of acidic or basic character at a given temperature. The pH of the water samples was found in the range of 7.21 – 7.51 in the first sampling and in the range of 6.98- 7.15 in the second sampling. All the sampling sites have pH in within the suitable and desirable range.

Electrical conductivity: Electrical conductivity is a measure of the ability of an aqueous solution to carry an electric current. It depends on the presence of ions, on their total concentration, mobility, and temperature measurement. A Higher value of conductivity shows a higher concentration of dissolved ions. The conductivity of water samples was found in the range of 872-874 µmhos/cm2 in the first sampling and 914-972 µmhos/cm2 in the second sampling. The conductivity of the water samples from the control site was 222 µmhos/cm2 and 254 µmhos/cm2 in the first and second sampling respectively. The conductivity of the water samples from the site 1 was 842 µmhos/cm2 and 914 µmhos/cm2 in the first and second sampling respectively. Similarly, the conductivity of the water samples from the site 2 was 874 µmhos/cm2 and 972 µmhos/cm2 in the first and second sampling respectively. Water samples from both the sites which are affected by the mining activities possess the electrical conductivity above the prescribed standards.

Turbidity: Turbidity, a key water quality test, is the cloudiness of the water which is an indication of the presence of suspended materials such as clay, silt, finely divided organic material, plankton, and other organic and inorganic materials. The turbidity of the water samples affected by the mining was recorded in the range of 15 -18 NTU in the first sampling and17-22 NTU in the second sampling, which is very much above the prescribed standards. The turbidity of the water samples from the control site was recorded as 8 NTU and 9 NTU in the first and second sampling respectively and these values are below the prescribed standards.

Total dissolved solids (TDS): The concentration of total dissolved solids in the water samples from the mining area was recorded in the range of 1.97-2.13 mg/l and 2.32-2.56 mg/l in the first and second sampling respectively. The values are more than the prescribed standards. However, the TDS of the water samples from the control site was found nearly in compliance with the prescribed standards.

Total alkalinity: Total alkalinity of the water samples from the mining area was found in the range of 300-312 mg/l and 285- 297 mg/l in the first and second sampling respectively. The total alkalinity of the water samples from the control site recorded as 552 and 437 mg/l in the first and second sampling respectively. The total alkalinity of the water samples from the mining area was found above the standard but below that of the water samples from the control site which shows the more acidic nature of the water samples affected from the mining area.

Free CO2: Free CO2 in the water samples from the mining area was observed in the range of 26.4 – 44.0 mg/l and 28.6 - 35.2 mg/l in the first and second sampling respectively. The free CO2in the samples from control site was recorded as 40.92 and 22 mg/l in the first and second sampling respectively. These findings clearly indicated that free CO2 level in all the samples was below the prescribed standards.

Chloride: The chloride level in the water samples from the mining area was recorded in the range of 99.4 - 106.5 mg/l and 146 – 188 mg/l in the first and second sampling respectively. The chloride level in the water samples from the control site was 142 mg/l and 103 mg/l in the first and second sampling respectively. The chloride level of all the water samples including the water sample from the mining area as well as the water samples from the control area was found below the prescribed standards.

Fluoride: The value of fluoride in the water samples taken from the mining area was found in the range of 1.5-2.7 mg/l and 1.5 – 2.8 mg/l in the first and second water sampling respectively. These values are very high above the permissible limits. However, the fluoride level in the water samples from the control area was found below the standards. The highest fluoride was observed in the water samples from site 2 (S2) which was 2.7 mg/l in the first sampling and 2.8 mg/l in the second sampling. A fluoride concentration of approximately 1.0 mg/l in drinking water effectively reduces dental caries without harmful effects on the health. Fluoride may occur naturally in water or it may be added in controlled amounts. Sometimes fluorosis may occur when the fluoride level exceeds the recommended limits12.

Dissolved oxygen (DO): Dissolved oxygen is an important water quality parameter indicating the quality of water. The values of DO were observed in the range of 3.2-4.1 and 3.8 – 4.8 mg/l in the first and second water sampling which is below the desirable standards. The DO level in the water samples from the control area was recorded as 5.2 and 6.9 mg/l in the first and second sampling respectively. These values are in compliance with the desirable standard.

Effect on air quality: The mining activities have a marked and profound effect on the air quality both in the mining area as wellas in the nearest residential area. The results clearly indicated that mining activities have a profound effect on the ambient air quality. The air quality parameters like SOx, NOx and suspended particulate matter was observed above the standards both in the mining area as well asin the residential area. The values of the SOx observed in all the samplings were observed in the range of 166.6 – 214 μg/m3 in the mining area and in the range of 102.4 – 127.3 μg/m3 in the residential area. Similarly, the values of NOx observed in all the samplings was observed in the range of 175.5 – 232.0 μg/m3 in the mining area and in the range of 125.7 – 141.1 μg/m3 in the residential area. The concentration of the suspended particulate matter ranges from 601.6 – 753.6 μg/m3 in the mining area and in the range of 311.7 – 361.9 μg/m3 in the residential area. The parameters observed were above the prescribed standards by Central Pollution Control Board both in the mining as well as in the residential area. Similar results were also recorded by various researchers for Indian coal mining areas16, 17. The impairment of ambient air quality in the residential area is more serious as a significant number of population is living in this area. The ambient air quality was seriously affected by the mining activities not only in the mining area but also in the nearest residential area. These pollutants can be a health hazard, exacerbating various respiratory disorders not only the workers but also with the common masses living in the nearest residential area18.

CONCLUSIONS

Extraction and processing of mineral resources play a pivotal role in the national economy of many developed and developing countries of the world. However, various environmental problems caused by mineral exploitation such as abandoned mines, biodiversity damage, use of hazardous chemicals with potential health risk to mine workers and neighbourhood communities deserved timely attention and intervention. The present study conducted in the mining industry of Shatabdipuram revealed that the various mining operations have a drastic and a strong negative effect on the local environmental quality. The concentration of various pollutants present in water and air is above the prescribed standards. Noise level created by various operations is also above the prescribed standards, which has made the mining industry noisy. The combined effects of above environmental problems have resulted into health problems with a high prevalence of diseases such as respiratory tract infections and health problems related to noise pollution in the local area. The need of the hour is to implement strong legislative measures to curb various negative environmental effects caused by the mining activities in the area. Adoption of sustainable technology and environmentally friendly procedures can substantially alleviate the negative consequences of the mining operations. Of course, the impacts of mining are many, not inevitable, but rather, possible to mitigate with appropriate regulation and enforcement, imposing accountability for local environmental and health quality, so that this robber industry can turn out to be a sustainable one.

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