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ENVIRONMENTAL CONCERNS ASSOCIATED WITH COAL MINING ACTIVITY - A CASE STUDY

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ABSTARCT

The Chasnalla block within the Jharia Basin is specially important for the coal mining activities. Consequence of mining activities involving drilling, blasting, crushing, transportation of coal etc. are the major concern for environmental pollution in the area. Mining and associated activities affect air, noise and water environment and degrades land and drainage system of the area. The extent of land degradation varies and is influenced by the topography of the area, geology, soil texture and method of mining. Damaged land adversely affects watershed and its drainage pattern, vegetation and biomass. To assess the impact of mining operation on different components of environment, monitoring of air, water, noise and soil environment as per TOR has been carried out at different pre-selected sites. Meteorological parameters are also regularly monitored at the selected site.

Overall evaluation damage due to mining activity presents the qualitative result of the existing condition with and without EMP. The net environmental changes arising out of proposed mining is beneficial with the guidelines of EMP. To mitigate the adverse impacts caused due to coal mining operation at Chasnalla OCP and for overall scientific development of local habitat, Environmental Management Plan (EMP) has been formulated. The EMP is based on the base line environmental status, mining methodology and environmental impact assessment. The EMP has prescribed environmental monitoring and implementation of environmental protection measures during and after mining operations.

In this paper, all technical, biological and socio-economic aspects are discussed and likely control measures are suggested in connection with air, water, noise and land and biological environment, socio-economic measures, EMP implementation and monitoring.

Key words : Drilling, Blasting, Crushing, Land degradation, TOR (Term of Reference), EMP (Environmental Management Plan), Environmental Impact Assessment

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INTRODUCTION

Chasnalla Block lies in the South Eastern extremity of Jharia Coalfield (JCF) in the Dhanbad district of Jharkhand state. It covers an area of 4.5 Km^2. The area is roughly defined by north latitudes $23^0 38'25''$ and 23''40'00'' and East longitudes $86^0 27'12''$ and $86^0 29'15''$. It is included in the survey of India Topo sheet No. 73 I/6 and in Sheet No. 8 of the geological map of JCF. Fig. 1 shows the regional location of the area. Chasnalla Block is located about 15 km from Jharia town and about 23 km from Dhanbad town. Dhanbad - Sindri Road passes through its northern boundary.

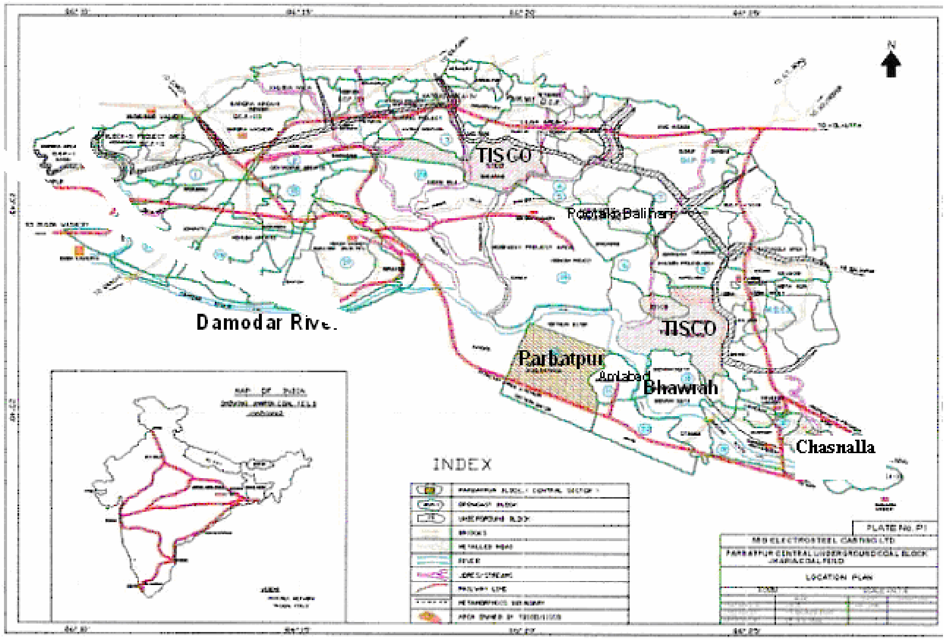

Fig. 1 : Location map of the Jhaia Coalfield and Chasnalla Block.

Physiography, drainage and climate

The area has a flat to gently undulating topography with a general southerly slope towards Damodar river, which flows west to east beyond the southern boundary of the block. The highest ground elevation is about 149 m. The drainage pattern in the present study area is dendritic in nature. The main drainage of the area is controlled by the Damodar river. Other major tributaries of Damodar river in the study area are Domohani, Kari Jora, Jiri Nadi, Gobai Nadi, Haral Nadi and Kadamdoha. Apart from these, a number of small ponds are found throughout the block. Most of the small ponds are formed due to illegal mine pits in the study area. The local drainage of the area is controlled by the two jores draining in Damodar river viz., Domohani jore and Cilatu (also called Chetu) jore.

The area lies in the tropical region with fairly wide temperature variations between winter and summer. The climate of Jharia Coalfield is tropical monsoon type with maximum precipitation occurring in the months of June to September. The maximum temperature of the coalfield rises upto 44°C in May while it dips to 5° to 7°C in December/ January. The annual rainfall in the Chasnalla Coalfield and adjacent regions varies from 1197 to 1380 mm.

Environmental impact of mining activities

Environmental pollution is a consequence of mining activities involving drilling, blasting, crushing, transportation of ore/coal etc. Mining and associated activities not only affect air, noise and water environment but it also degrades land and drainage system of the area[1]. To assess the impact of mining operation on different components of environment, one season monitoring of air, water, noise and soil environment as per TOR has been carried out for summer season at different pre-selected sites. The meteorological parameters are also regularly monitored at the selected site. The environmental status of the different monitored parameters is discussed briefly in following paragraphs.

Air environment

Air pollution includes one or more contaminants (pollutants), in the outdoor atmosphere in such quantities and of such duration that may be injurious to human, plant or animal life. Once these contaminants enter in the atmosphere, either in gaseous form or as particulate matter, these cannot escape and keep circulating and deteriorating the air quality. Air pollution effects encompass those that are health related as well as those associated with damage to property or which cause decreases in atmospheric aesthetic feature. Examples of air pollution effects on human health include eye irritation, headaches and aggravation of respiratory problems. Plants and crops have been subjected to the undesirable consequences of air pollution, including abnormal growth pattern, leaf decolouration and death. Dispersion of air pollutants from the source depends on micro-meteorological parameters of the area. Micro-meteorological parameter is essential to assess the pollution level in the area as well as helpful in taking precautionary measures to control, the levels.

Micro-meteorology

Micro-meteorological properties of the atmosphere, govern the concentration of pollutants and its variation with time and location, with respect to the emission source. The severity of the pollution depends on the various meteorological variables. This includes wind speed and direction, atmospheric diffusion, variation of temperature with height and mixing height. Meteorological data for one-year duration have been collected from the secondary sources for nearby station. The meteorological parameters depict the weather condition of a typical summer month and the climate of the area is dry humid and sub-tropical. It is characterized by hot and dry summer (March to June), rainy season (July to October) and winter (November to February). The average annual relative humidity is about 63%. In summer months, the relative humidity (RH) varies between 32 to 72%. The temperature rises up to 42^0 to 46.3^0C on some summer days and in winter, the temperature drops down to 5^0 – 7^0C at times. In the monitored summer months of May 2006, the temperature ranges from 28^0 to 46.3^0C. Dust storms are common in dry season (May and June) before the onset of monsoon with increase in temperature and wind speed in the afternoon coupled with low humidity. Major rainfall occurs during monsoon and the maximum rainfall occurring in the month of August. The average annual rainfall (2006) in the area is reported to be 866 mm and number of rainy days in a year is about 95 days. The long term average annual rainfall of the area is around 1200 mm. The wind speed of the area varies from 2.9 to 16.0 km/hr.

Water environment : Surface water resource

Information on water resources in the study area was collected. The water resource in the study area are mainly river, ponds and groundwater. Damodar river flowing to the east forms the north-eastern boundary of the Chasnalla block. The river afterwards turns south and forms part of the south eastern boundary of the block. This controls the main drainage of the area. Though some ground water have been tapped by shallow wells for drinking and irrigation needs, the deep aquifers were neglected in most of the area. With proper technique, the ground water can be successfully tapped to meet the water demand both for domestic and agriculture. The common sources used for domestic and irrigation in the core zone villages include shallow dug wells, river and ponds. The other system is tapping deep aquifers in some of the villages by deep tube wells i. e. hand pumps. These wells have an average depth of 30-40 meters. In the reconnaissance survey, it is found that most of the villages have two to three tube wells and/or dug wells; either belonging to the private or public. The water table in the dug wells ranges in between 6-14 m except in few cases when the water table is somewhat deeper.

Water quality, methods of sampling and analysis

To assess the impact of mining on water quality, eight water samples have been collected from different locations. This comprises of five dug and tube well water, two river water and one pond water samples (Table 1). Locations of sampling points are shown in Fig. 2. All the water samples have been collected in the May 2007 and analysed as per standards APHA[2].

Table 1 : Details of water quality monitoring stations

Stn. Code	Location	Remarks
	Drinking water	
W – 1	Well water at Tasra	Drinking water
W – 2	Well water at Kandra	Drinking water
W – 3	Tube well water at Rohraband	Drinking water
W – 4	Well water at Malikkulhi	Drinking water
W - 5	Tube well Gosalla	Drinking water
	Surface water	
W – 6	U/S of Damodar river	Base line data to evaluate the impact of mining
W – 7	D/S of Damodar river	Base line data to evaluate the impact of mining
W – 8	Pond water at Bhaghmara	Pond water

The water samples were collected and analysed as per IS : 10500[3] standards. Results of ground water and surface water analysis have been given in the Tables 2 and 3, respectively. Concentration of some ions like SO_4 and Cl and value of TDS are relatively high in some ground water and pond water samples. However, in general all the measured values are found well within the threshold limit as specified in test parameters of drinking water, ICMR[4]; WHO[5].

Table 2. Drinking water quality of the study area (ground water)

Parameters	Station Code					IS : 10500
	W1	W2	W3	W4	W5	
Colour (Hazen units)	<5	<5	<5	<5	<5	5-25
Odour	Unobject	Unobject	Unobject	Unobject	Unobject.	Unobject
Taste	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
Turbidity (NTU)	<5	<5	<5	<5	<5	5-10
pH	8.13	7.36	7.83	8.1	8.1	6.5-8.5
Total H (as $CaCO_3$)	198	210	238	225	253	300-600
Iron (as Fe)	0.1	0.19	0.13	0.18	0.25	0.3-1.0
Chloride (as Cl^-)	27.6	53.2	43.2	36	15.4	250-1000
Residual free chlorine	<0.1	0.1	0.11	<0.1	0.12	0.2
TDS	430	549	460	533	735	500-2000
Calcium (as Ca)	41.5	49.1	69.1	57.8	85.5	75-200
Magnesium (as Mg)	21.9	19.7	33.7	29.5	29.8	30-100
Copper (as Cu)	0.04	0.02	0.03	0.03	0.02	0.07-1.5
Manganese (as Mn)	0.’07	0.07	0.04	0.06	0.’07	0.1-0.3
Sulphates (as SO_4^{2-})	36.8	101.6	75.6	52.5	212.4	150
Nitrate (NO_3^-)	1.28	3.32	5.89	1.46	0.84	45-100
Fluorides as (F^-)	0.23	0.26	0.29	0.39	0.24	0.6-1.2
Phenolic com. (C_6H_5OH)	BDL	BDL	BDL	BDL	BDL	0.001
Mercury (as Hg)	BDL	BDL	BDL	BDL	BDL	0.001
Cadmium (as Cd)	BDL	BDL	BDL	BDL	BDL	0.01
Selenium (as Se)	BDL	BDL	BDL	BDL	BDL	0.001
Arsenic (as As)	BDL	BDL	BDL	BDL	BDL	0.07
Cyanide (as CN^-)	<0.01	<0.01	<0.01	<0.01	<0.02	0.07
Lead (as Pb)	0.07	0.03	0.02	0.06	0.02	0.1
Zinc (as Zn)	0.11	0.09	0.07	0.11	0.13	0.5

Table 3 : Surface water quality of the study area (Surface water)

Parameters	Station Code		
	W6	**W7**	**W8**
pH	7.8	8	8.12
Colour, Hazen Units	Colorless	Colorless	Colorless
Total Dissolved Solids	275	312	668
Dissolved Oxygen	7.3	6.4	9.8
BOD (5 days at 20^{o}C)	4.3	3.9	4.1
Chloride (as Cl^-)	10.6	13.4	66.6
Boron (as B)	BDL	BDL	BDL
Sulphate (as SO_4^{2-})	32.8	42.7	99.4
Nitrates as NO_3^-	1.5	1.7	10.7
Free ammonia as N	BDL	BDL	BDL
Conductivity (µs/cm)	312	365	789
Arsenic (as As)	BDL	BDL	BDL
Iron (as Fe)	0.1	0.13	0.15
Fluorides (as F^-)	0.67	0.57	0.41
Lead (as Pb)	0.’07	0.03	0.09
Copper (as Cu)	0.09	0.03	0.1
Zinc (as Zn)	0.04	0.’07	0.12
Sodium absorption ratio	35	39	56
Coliform organism (MPN /100 mL)	312	337	626
Classification	**C**	**B**	**B**

Note :

All parameters are expressed in mg/L except pH and colour.

As per classification of inland surface water (CPCB standard)

CL : Colourless

BDL - Below Detection Limit.

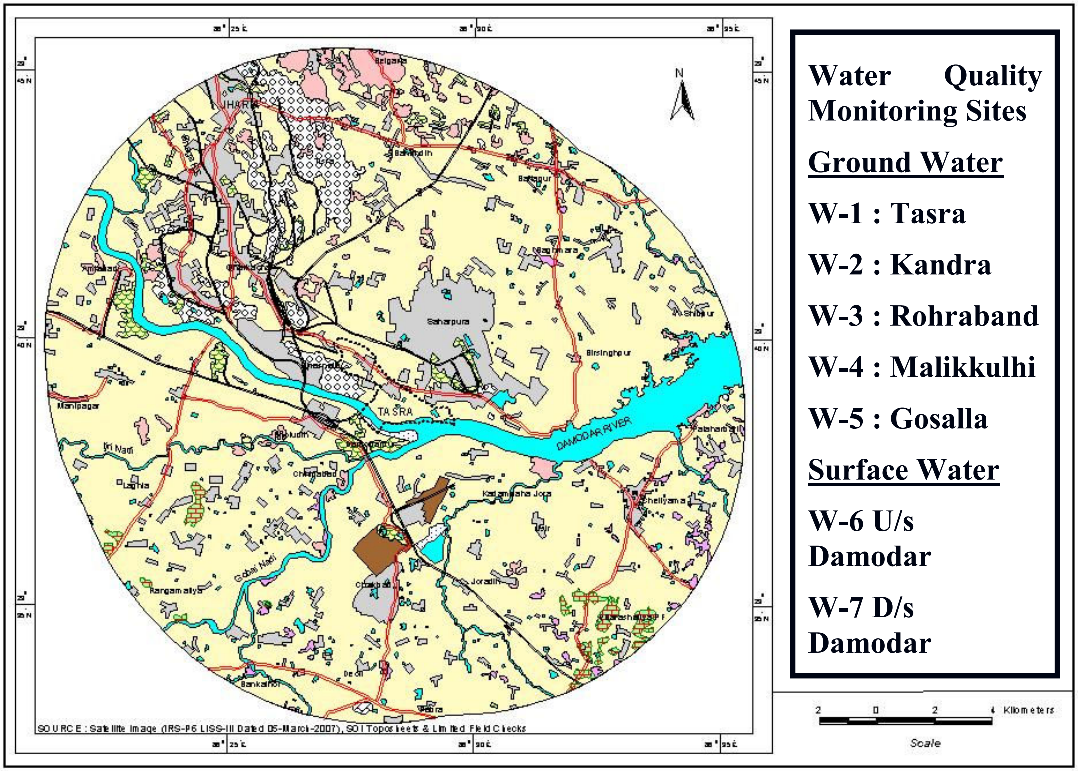

Fig. 2 : Location of water sampling points

Hydrogeology and aquifer characteristics of the area

Groundwater occurrence and storage in study area are mainly controlled by the geological set up of the area. The ability of geological formation to store and transmit water is dependent on its formation parameters, such as porosity and hydraulic conductivity. Based on these two parameters, the rock formation of the area may be classified as hard and soft rocks. Hard rocks, mainly crystalline and consolidated sedimentary is characterised by very little porosity. Ground water in such rocks circulated to a limited extent through the secondary openings represented by joints, cracks, fissures and such other planes of discontinuity. Soft rocks represented by sandstone, pebbles and loose sand, posses higher degree of primary porosity and as such characterized by higher water storage capacity. As greater part of the study area is underlain by Precambrian crystalline rocks, the weathered residual of the hard rocks as well as the fractures, joints, fissures, faults and other zones of discontinuity are the principle repositories of ground water in the area. The weathered zone is usually of limited thickness, fractures and joints generally close up with depth. The thickness of weathered mantle in the hard rock zone of area is about 10-20 meter in the topographic lows. Ground water in the weathered and fracture zones of hard rocks occur under unconfined condition. Ground water circulating through fracture zone is sometimes held under pressure. Depth of the water table in the hard rock of the area generally ranges from 3.0 m to 10.0 m below ground level.

The Gondwana sediments form the semi-consolidated formations and are better water potential zone. The splintery shales of Talchir and basal pebbles bed, the variegated Barren Measure shales and the sandstones are the major lithounits of the Gondwana formations. Gondwana sandstones in general, are known to constitute good aquifers at many places. Ground water occurs under unconfined condition in the weathered mantles having varying depths of 7-14m as observed in the dugwells and semiconfined condition in the deeper aquifers. Depth of water level for pre-monsoon period varies from 4-5 m bgl around the Chasnala block whereas at some places, it stretches to a deeper depth of 8-12 m. The pre-monsoon water levels rises due to recharge and becomes 3-6 m bgl around Chasnalla area during post-monsoon period.

Land environment

Land environment is an aspect, which gets damaged the most, during the mining operations. The extent of land degradation however, varies and is influenced by the topography of the area, geology, soil texture and method of mining. The damaged land adversely affects watershed and its drainage pattern, vegetation and animal communities.

Land use pattern

Chasnala Block Project includes villages namely Tasra, Rohraband, Kandra, in Core zone. The present lease area in Tasra Central Block of Jharia coalfield is 4.5 km^2. Lease area does not include any forest land. The Chasnalla block is bounded in south by Damodar river. Core zone is covered on all the sites by villages having irrigated, un-irrigated cultivable and waste land. Agriculture, coal mining and coal based industrial activity are the major sector for occupation in the core and buffer zone. However, in the absence of irrigation facility, the farmers cultivate only in one season. The main crop is rice. Other crops grown in the area are Paddy, Maize, Jawar, Nawa, Bajra, Arhar, Urad, Moong, Khesari, Alsee and Mustard in the winter and rainy seasons.

Soil quality

To assess the mining impact on soil in and around Chasnalla Block, the effect on agricultural field, baseline soil quality of the area has been evaluated with respect to physical and chemical parameters. The physical properties of soil, which are important for plant growth and agricultural productivity is : texture, bulk density, moisture content and water holding capacity. The chemical properties, which govern growth performance of crops and plant, are pH, EC, N, P, K and organic carbon.

S1 - Tasra agriculture field

S2 - Waste land near Kandra

S3 - Amlabad agricultural field

S4 - Barren land of Joradih

Methodology

Soil sampling has been carried out in the month of May 2007.The standard IS procedure as mentioned below has been followed for sampling and all the sampling have been taken from the depth of 0-30 cm. and 30-60 cm. from all the sites.

Physical parameters

(i)	Colour	Visual observation
(ii)	Natural moisture content (%)	IS : 2720 Part II (1973)
(iii)	Bulk density (g/cm^3)	IS : 2720 Part XXIX (1975)
(iv)	Particle size analysis	IS : 2720 Part II (1973)
(v)	Water holding capacity	

Chemical properties

(i)	pH	IS : 2720 Part XXIX (1973)
(ii)	Electrical conductivity(mho/cm)IS	2720 Part XIX (1977)
(iii)	Organic carbon (%)	IS : 2720 Part XXII (1972)
(iv)	Available N (Kg/ha)	Micro Kjeldhal method
(v)	Available P (Kg/ha)	Olsen method (1954)
(vi)	Available K (Kg/ha)	Ammonium acetate extractable (AAS)

RESULTS AND DISCUSSION

The general topography of the area is undulating and rolling upland having valley bottom plain or depression between uplands. The soils of these areas have developed over graniticgneiss, occurring on upland, gently sloping with undulating surrounding country land. These soils are fine loamy to fine textured and red to yellowish red to greyish in colour. These soils have moderate erosion. The soils are characterised by moderately acidic to neutral in nature, low organic carbon status, deficient in nitrogen and phosphorous, medium potassium content with medium available water holding capacity. Four samples comprising of wasteland, agricultural field and barren land have been analysed for their physico–chemical properties. The results of analysis are presented in Table 4.

Physico–chemical properties

To predict the future mining impact on soil quality in and around Chasnalla Block, the baseline soil quality of the area has been evaluated with respect to physical and chemical parameters. Analysis of soil samples reveals that there is no wide variation in the natural material. Particle size analysis shows that the texture of the soil is of sandy loam in nature. The bulk density was found to vary from 1.35 to 1.57 g/cm^3 showing compactness while moisture content ranged from 8.8% to 15.2%. All the samples showed moderate water holding capacity ranging from 24.63 to 36.68 %. Further, soil of agricultural field was found slightly acidic in nature while the waste land soils samples shows neutral pH. Electrical conductivity measurement of the samples clearly suggests that total soluble solid concentration are in the normal range and all the values are found below 1 m mho/cm the values of EC ranged from 0.18 to 0.27 mho/cm. The values of organic carbon of all samples were found to be lower. Available phosphorus and potassium have been found in medium range.

Biological environment

Biological environment is one of the most important aspects in environmental impact assessment in view of the need for conservation of environmental quality for environmental management and planning. Eco-systems consist of varieties of interrelationships between both abiotic and biotic components including dependence, competition and mutualism. Biotic components comprises of both plant and animal communities which interact not only within and between themselves but also with the abiotic components of the environment. Generally a biological ecosystem, being dependent on the climatic condition and resources of its location, may change if there are any human impacts in the abiotic environment.

Table 4: Physico–chemical properties of soil

Parameters	Sampling locations							
	S1		S2		S3		S4	
	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm
Physical parameters								
Sand (%)	65.8	66.3	69.4	68.5	67.8	65.8	65.9	59.4
Silt (%)	17.7	22.5	21.4	20.4	21.7	20.3	19.9	28.2
Clay (%)	14.8	1102	11.5	12.7	11.6	13.9	14.8	12.2
Texture	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
Bulk density (g/cm^3)	1.48	1.43	1.45	1.57	1.46	1.35	1.48	1.53
Moisture content (%)	10.6	9.3	8.8	9.1	15.2	10.9	12.2	9.8
Water holding cap. (%)	24.63	26.28	28.94	28.94	24.65	36.68	27.79	24.39
Chemical parameters								
pH	6.5	6.2	6.5	6.5	6.9	7.5	7.3	7.4
EC (mho/cm)	0.21	0.23	0.26	0.23	0.19	0.18	0.25	0.27
Organic carbon (%)	0.28	0.27	0.26	0.25	0.23	0.24	0.35	0.32
Available N (Kg/ha)	268	232	238	246	245	234	298	286
Available P (Kg/ha)	23	22	23	21	95	22	19	23
Available K (Kg/ha)	139	142	144	137	129	127	135	139

A number of variables like temperature, humidity, atmospheric conditions, soils, topography, etc. are responsible for maintaining the homeostasis of the ecological environment and change in any one of the variables may lead to stress on the ecosystem. Plant and animal communities in their natural habitat exist in a well-organised manner obeying food chain, food web complex and laws of thermodynamics for sustainable development. This natural equilibrium may be disturbed by any external man induced or nature-induced influences. The disturbance should not cross beyond resilience level. So, once this equilibrium is disturbed, it becomes practically impossible or takes a longer time to come to its original state. Plants and animals are more susceptible to environmental stresses and resilience. A change in the composition of the biotic communities is reflected as a change in the distribution pattern, diversity, dominance of the natural species of flora and fauna existing in the ecosystem. These changes over a time span can be quantified and related to the existing environmental factors. The sensitivity of plants and animal species to the changes occurring in their existing ecosystem can, therefore, be used for Environmental Impact Assessment studies for sustainable development. The weight to biological environment is given in Table 5.

Table 5. Weight to biological environment

Parameters	PIU	Baseline EIU (a)	Without EMP (b)	With EMP (c)	Change EIU (c- b)	Change EIU (b- a)	Change EIU (c- a)
TERRESTRIAL (200)							
Green cover	50	46	36	48	12	-10	2
Crop yield	40	37	20	30	10	-17	-7
Rare and endangered plant sp.	30	0	0	0	0	0	0
Rare and endangered animal sp.	20	0	0	0	0	0	0
Vegetation diversity	30	26	10	24	14	-16	-2
Fauna diversity	30	25	10	24	14	-15	-1
Total	**200**	**134**	**76**	**126**	**50**	**-58**	**-8**

Cont…

Parameters	PIU	Baseline EIU (a)	Without EMP (b)	With EMP (c)	Change EIU (c- b)	Change EIU (b- a)	Change EIU (c- a)
AQUATIC (100)							
River flow	50	48	40	48	8	-8	0
Aquatic Natural vegetation	20	18	16	18	2	-2	0
Photoplankton diversity	10	8	6	8	2	-2	0
Zooplankton diversity	10	8	6	6	0	-2	-2
Benthal flora and fauna	0	0	0	0	0	0	0
Algal growth	10	8	6	6	0	-2	-2
Fish yield	0	0	0	0	0	0	0
Total	**100**	**90**	**74**	**86**	**12**	**-16**	**-4**
Grand Total	**300**	**224**	**150**	**212**	**62**	**-74**	**-12**

The assigned PIU for biological environment is 300, i. e. 200 for terrestrial environment and 100 for aquatic environment. The parameters taken into account are flora and fauna with their habitats. The baseline EIU as found to be 224 units. If mining activity is undertaken without EMP, the biological environment is likely to deteriorate significantly. There would be a deterioration of 74 points as compared to baseline status. However, if EMP is implemented properly, deterioration is likely to be less than of 12 points and it would improve to 212 points. The overall deterioration in biological environment will be - 12 points and is mainly due to loss of vegetation, dumping of overburden, increase of coal dust particles etc.

Survey methodology

A preliminary survey of the study area has been performed to get a general picture of the landscapes in vegetation. Traverses have been taken within different areas of the study area to note major vegetation patterns and plant communities including their growth form and dominant species and the human as well as mining influence on vegetation.

Plants, which could not be identified in the field, have been collected, pressed and brought to the laboratory for identification.

Socio-economic studies : Industrialization

The main occupation of the people of leasehold and adjoining area is cultivation and collection of coal. Besides this, peoples are engaged in coal mines and coal based industries. There are many coal based industry, workshop, garage etc. in adjoining area like Bhojudih, Chasnalla, Bhowra, Jharia and Dhanbad which provide jobs at different levels. It is supposed that opening of the coal mine will create good job prospects for the local people future.

Environmental impact studies

Different segment of environmental pollution, PIU (Parameter Importance Unit) of different parameters as described below are given account to their importance, Table 6.

Table 6.Weight to environmental pollution

Parameter	Weight (PIU)	Baseline (EIU) (a)	Without (EMP) (b)	With EMP (c)	Change (EIU) (c - b)	Change (EIU) (b - a)	Change (EIU) (c - a)
WATER (140)							
BOD	20	18	12	16	4	-6	-2
DO	20	18	12	16	4	-6	-2
TDS	20	15	8	13	5	-7	-2
TSS	25	23	7	20	13	-16	-3
Toxic Sub.	20	18	15	17	2	-3	-1
Faecal Matter	5	3	2	3	1	-1	0
pH	10	9	7	9	2	-2	0
Temp.	10	9	7	8	1	-2	-1
Nutrient	10	9	7	8	1	-2	-1
Sub-total	140	122	77	110	33	-45	-12

Cont…

Parameter	Weight (PIU)	Baseline (EIU) (a)	Without (EMP) (b)	With EMP (c)	Change (EIU) (c - b)	Change (EIU) (b - a)	Change (EIU) (c - a)
LAND (140)							
Land use pattern	60	50	30	45	15	-20	-5
Soil erosion	40	37	20	38	18	-17	1
Chemical nutrients	40	36	31	36	5	-5	0
Sub-total	140	123	81	119	38	-42	-4
AIR(140)							
RPM	50	39	31	37	6	-8	-2
SPM	40	37	28	31	3	-9	-6
SO_2	15	12	8	14	6	-4	2
NOx	20	15	10	14	4	-5	-1
CO	5	5	4	5	1	-1	0
Pb	10	10	8	10	2	-2	0
Sub-total	140	118	89	111	22	-29	-7
NOISE POLLUTION (30)							
Com. Noise	20	18	10	16	6	-8	-2
Vibration	10	8	6	7	1	-2	-1
Sub Total	30	26	16	23	7	-10	-3
Grand Total	**450**	**389**	**263**	**363**	**100**	**-126**	**-26**

(a) Water

In case of water environment, total PIU is 140.Parameters considered are BOD, DO, TDS, TSS, toxic substance, excretal matter, pH, temperature and nutrient. Baseline EIU of all the parameters are found to be 122 points, which would deteriorate to 77 points if EMP measures were not employed. The parameters that are likely to deteriorate most are TDS, TSS and toxic substances. If EMP measures are employed, the EIU would increase to 110 points, however even with EMP there would be net degradation of water environment amounting to change of PIU values by -12 points.

(b) Land

In case of land environment, the total PIU is 140 and baseline EIU is 123 units. The parameters considered are land use pattern, soil erosion and chemical nutrients. All these parameters will be greatly damaged by mining activities. If EMP measures were not undertaken, the EIU values would decrease to value of 81.However in case of EMP measures implemented, the land environment is likely to improve back upto EIU value of 119.However there will be net negative impact of 4 points as compared to baseline environment.

(c) Air

In case of air environment, the total PIU is 140 units. The parameters considered are RPM, SPM, SO_2, NOx, CO and Pb. The base line EIU is found to be 118 points. Due to mining activities, the concentration of RPM, SPM, NOx and Pb are likely to increase resulting in significant deterioration of air environment. If EMP measures are not undertaken, the magnitude of deterioration is likely to -29 points in terms to PIU. However, if EMP measures are implemented, the air environment may substantially be improved by 111 points. Even with implementation of EMP, there would be negative impact of 7 points in terms of baseline EIU.

(d) Noise

In case of noise environment, the total PIU is 30 and the baseline EIU is 26 units. The parameters considered are community noise and vibration. There will be deterioration in both the parameters by mining activities. If EMP measures were not undertaken, the EIU values would be of 16 points. But if EMP measures are implemented this noise environment would improve upto an EIU value of 23 points. However there will be net negative impacts of 3 points as compared to baseline environment.

The overall PIU for the environmental pollution category is 450 units and the baseline PIU was found to be 389 units. It would decrease to 263 units if EMP measures were not undertaken. But if EMP measures are employed properly, the deterioration could be minimised significantly to 363 units. There would only be negative impact of 26 points as compared to the baseline status.

Aesthetic environment

The assigned PIU for aesthetics environment is 100 as shown in Table 7.

Table 7.Weight to aesthetic environment

Parameter	Weight (PIU)	Baseline (EIU) (a)	Without EMP (b)	With EMP (c)	Change (EIU) (c - b)	Change (EIU) (b - a)	Chan-ge (EIU) (c - a)
Aesthetics Environment (100)							
Landscape	30	25	15	22	7	-10	-3
Appearance of water body	20	19	13	18	5	-6	-1
Visibility	20	16	13	15	2	-3	-1
Greenery	20	17	13	18	5	-4	1
Composite effect	10	9	6	7	1	-3	-2
Total	**100**	**86**	**60**	**80**	**20**	**-26**	**-6**

Table 8. : Weight to socio-economic environment

Parameter	Weight (PIU)	Baseline (EIU) (a)	Without (EMP) (b)	With EMP (c)	Change (EIU) (c - b)	Change (EIU) (b - a)	Change (EIU) (c - a)
Socio – economic (150)							
Housing facility	15	12	12	12	0	0	0
Employment opportunity	15	5	10	13	3	5	8
Health facility	15	6	11	13	2	5	7
Sanitation facility	15	7	11	13	2	4	6
Educational facility	15	6	11	12	1	5	6

Cont…

Parameter	Weight (PIU)	Baseline (EIU) (a)	Without (EMP) (b)	With EMP (c)	Change (EIU) (c - b)	Change (EIU) (b - a)	Change (EIU) (c - a)
Public transport facility	15	7	13	14	1	6	7
Drinking water supply	15	9	12	13	1	3	4
Power supply	15	8	12	12	0	4	4
Perishable food prices	7	6	4	4	0	-2	-2
Land prices	8	4	6	8	2	2	4
Public security	15	5	9	10	1	4	5
Total	**150**	**75**	**111**	**124**	**13**	**36**	**49**

The parameters taken into account are landscape, appearance of water body, visibility, greenery and composite effect. The baseline EIU was found to be 86 units. If mining activity is undertaken without EMP, the aesthetic environment is likely to deteriorate significantly. There would be a deterioration of 26 points as compared to baseline status. However if EMP is implemented properly, deterioration is likely to be less than of 20 points and it would improve to 80 points. The overall deterioration in aesthetic environment will be - 6 points and is mainly due to loss of vegetation, removal and dumping of overburden, increase of coal dust particles etc.

Socio–economic environment

The evaluated value for socio-economic environment is shown in Table 8. Its PIU is 150 units. Its baseline EIU value was found to be 75 units, which indicate that the area is under developed before the mining activity started. If mining is undertaken, the socio-economic environment will improve to 111 units. This improvement is without implementation of EMP. It improves further to 124 units when EMP measures are implemented. Its shows that mining will cause tremendous improvement compared with baseline EIU i. e. improvement of 13 units. The overall improvement in socio-economic environment will be of 49 units. This improvement is due to good infrastructural facility, generation of employment, better security etc.

Overall impact assessment

A summary of overall evaluation damage due to the proposed mining activity at Chasnalla block open cast project is presented in Table 9. It presents the qualitative result of the existing condition with and without EMP. The net environmental changes arising out of proposed mining is beneficial with the guidelines of EMP. The total weight prescribed is 1000 units of which the existing baseline environmental status under categories is 774 units (a). However, with the adverse impact on environment due to proposed mining area, it reduces to 584 units (b) without EMP. The quality of environment for the project without EMP (b) when compared to the quality of existing environment (a) gives change (b - a), which indicates a change of -190 units. Thus, it is adversely affecting the four segments of environment without proper EMP. The quality of environment due to project with a sound EMP has a score of 779 units (c). This score, when compared to the quality of environment without EMP (b) gives a change (c - b), which indicates a change of 195 units. Thus, net impact of project on environment with a proper EMP is 5 units.

Table 9 : Overall environmental impact

Parameters	Weight (PIU)	Baseline EIU (a)	Without EMP (b)	With EMP (c)	Change EIU (c-b)	Change EIU (b-a)	Net Change (c- a)
Biological	300	224	150	212	62	-74	-12
Environmental pollution	450	389	263	363	100	-126	-26
Aesthetic	100	86	60	80	20	-26	-6
Socio-economic	150	75	111	124	13	36	49
Total	**1000**	**774**	**584**	**779**	**195**	**-190**	**5**

Environmental management/mitigative measures

To maintain ecological balance and to check harmful effects due to mining and allied activities at Chasnala OCP, environmental control measures have to be integrated into the processes of mining planning. Many of the areas of environmental management planning require multidisciplinary approach. Environmental management approach includes action to protect environment by using instruments, direct regulatory instruments or technological instruments[6,7]. It provides the remedial solutions of the problem, which is assessed by the data collected from the environmental impact evaluations and base line data. It also takes into account the existing scenario of the future scenario due to industrial activities. Thus, environmental management plan is essential for sustainable development of the region. The measures envisaged in the EMP report are based on the information revealed from data bank of base line environmental status, mining methodology and environmental impact assessment. Therefore, these measures are regarded as guidelines and depending upon the continuing advice to be taken from experts of relevant field like; forestry, hydrology, geochemistry etc. the suggested schemes are to be detailed. If necessary, may be modified from time to time to meet statutory requirements. To mitigate the adverse impacts caused due to coal mining operation at Chasnalla OCP (Open Cast Project) and for overall scientific development of local habitat, the Environmental Management Plan (EMP) has been formulated. The EMP is based on the base line environmental status, mining methodology and environmental impact assessment. The EMP has prescribed environmental monitoring and implementation of environmental protection measures during and after mining operations with reference to :

(i) Air environment

(ii) Water environment

(iii) Noise environment

(iv) Land and biological environment

(v) Socio-economic measures

(vi) EMP implementation and monitoring

(vii) Disaster management plan

CONCLUSIONS

The impact of mining operation on different components of environment, monitoring of air, water, noise and soil environment as per TOR has been carried out for at different pre-selected sites. Overall evaluation damage due to mining activity presents the qualitative result of the existing condition with and without EMP. The net environmental changes arising out of proposed mining is beneficial with the guidelines of EMP. In order to mitigate the adverse impacts caused due to coal mining operation at Chasnalla OCP and for overall scientific development of local habitat, Environmental Management Plan (EMP) has been formulated. The EMP is based on the base line environmental status, mining methodology and environmental impact assessment. The EMP has prescribed environmental monitoring and implementation of environmental protection measures during and after mining operations and has been a successful tool for assessing the impact of environmental pollution. The overall environmental impact on account of biological, environmental, aesthetic and socio–economic parameters have been achieved to a great extent on account of EMP.

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