

## Effect of mine spoil on native soil of Lower Gondwana coal fields: Raniganj coal mines areas, India

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### ABSTRACT

Mine spoil characteristics of the dump area and the native soil are analyzed critically to evaluate any deterioration in soil properties. The required level of soil nutrient of mine spoil is less than that of the native soil. Available nutrients (N, P, K), exchangeable cation (Ca, Mg, Na, K) of the native soil suggest that open cast mining changes the soil quality. Other physical properties of the mine spoil such as bulk density, water holding capacity, moisture content are lower than those of native soil. Mining method alters the soil texture from silty-loam to sandy soil, but old mine spoil at Belbad has regenerated from sandy to silty-loam type. There have been no such significant differences in trace metal content in mine spoil and native soil.

**Keywords:** Mine spoil, Available nutrient, Native soil, Exchangeable cation, Open cast mining, Trace element.

### 1. Introduction

A blend of quality soil and different climatic parameters favors the growth of plants and agriculture which is considered to be the back-bone of the economy of any country. The paper thin layer of soil as compared to the total crustal thickness (33km) of the earth not only provides us food but also the habitat of soil micro organism which are driving force of many ecosystems. Many workers around the world have reported various effects of mining (Banerjee et al., 2004; Dutta et al., 2002; Ekka et al., 2011; Ghose, 1996 ; Singh et al., 2006). On a global scale about 20 percent deforestation in developing countries may be attributable to mining (Bahrami et al., 2010). Ghosh (1990) reported that in India every one million tons of coal extracted by surface mining methods damages a surface area of about 4 ha. Mining soil has high content of rock fragments in comparison to fine earth. These spoils are not suitable for both plant and microbial growth because of low organic matter content, unfavorable pH (Agrawal et al., 1993; Burghardt, 1993). Pederson et al., 1988 observed that, the nutrient status of overburden soil is also a major factor limiting plant growth. Open cast excavation of coal deposits involves the removal of overlying soil and rock debris and their storage in overburden dumps change the natural land topography, affect the drainage system and prevent natural succession of plant growth (Bradshaw et al., 1980; De et al., 2002; Wali, 1987). The change in land use in the form of open cast mining also affects the local hydrological cycle including ground water. Due to lack of vegetation cover of the large areas of open cast mines the quantum of evaporation considerably increases affecting the water balance of the area and as a consequence of which permanent lowering of water table may

take place. With the lowering of water table the possibility of occurrence of land subsidence in the mining areas also increases. Top soil confine humus, an important food resource for plants, which increase biological activity, soil fertility and control the air and water content of soil and thereby determine the suitability of reclaimed sites for revegetation and its successful successional development (Wilson et al., 2002). In the process of opencast mining, damage the top soil layer and its effect several changes of the physical, chemical and microbiological properties of soils (Kundu et al., 1998b). Mining operations degrade significant areas of land and replace existing ecosystem with undesirable waste materials in form of mine spoil dumps (Singh et al., 2007). Mine spoil are anthropogenic which cause a wide range of problems for establishing and maintaining vegetation cover. Leachates generated from overburden dump may change the characteristic of surrounding of top soils. The adverse physico-chemical properties tend to inhibit soil forming process and plant growth. In overburden dumps, along with increased metal concentration there are simultaneous decrease in parameters like organic carbon content, available nutrients as well as exchangeable cation etc. (Maiti, 2007). The dumps of mine spoil are environmentally very unstable. Such dumps cause destruction of original habitat and land, air pollution, increase in heavy metal concentrations in surroundings, water pollution by increasing the suspended solid load in the water bodies. Rainwater percolates through these overburden dumps, get mixed with the surface water as well as underground water in the form of leachate causing further water pollution. Restoration of mined areas is essential to restore the ecological balance of the ecosystem and maintain a self sustain ecosystem where in all essential ecological process take place (Verma, 2003). An attempt has been made in this study to address the problem of alteration of native soil in the Lower Gondwana coal fields of this part of India which is long overdue. The main objective of the study is to understand the effects of these mine spoils on the natural vegetation (if any) of the area because these mine spoils turn into native soil in course of time. Certain parameters, viz. available nutrients (Nitrogen, Potassium, and Phosphorus), exchangeable cation (Calcium, Magnesium, Sodium, Potassium) etc. of mine spoil and native soil are chosen for analysis as these are primary requirements for plant growth. The study not only helps to compare the quality of the mine spoil and native soil but also helps in understanding the future scope of growth of vegetation in the region. An assessment of trace element concentration in mine spoil and surrounding top soil has been made to provide the base line data for future research.

### **1.1 Study Area**

The present study area are belongs to ECL (Eastern Coal Field Limited) under Raniganj Coal field West Bengal, India. This study has been carried out in four open cast coal mines, namely Damalia, Mahabir, Nimcha, Belbad and their adjoining areas. The study area falls within the Survey of India toposheet number 73 M/2 and is bounded within latitudes from 23°35'N to 23°41'N, and longitudes from 87°04'E to 87°13'E (Figure 1).

### **1.2 Climate**

The climate of the study area is in general dry tropical. The area experiences three prominent seasons, summer (middle of March to middle of June) monsoon rain (middle of June to Middle of October) and winter (November to February). In summer average temperature ranges between 38<sup>o</sup>c to 43<sup>o</sup>c, some time it may be rises up to 48<sup>o</sup>C temperature. The area receives average annual rainfall between 1240 to 1500 mm.

### **1.3 Geology and soil of the surrounding area**

The coal seams of Gondawana super group were formed in association with sandstone and shale as cyclothem repetition. In comparison to other Gondawana coal of the world Indian Gondawana coal is characterized by high ash content. High ash content is indicative of high mineral matter content of the coal. The mine spoil is composed of weathered products of sandstone and shale of Raniganj formation of Gondwana Super group. Sandstone occurs as dominant mine spoil, mainly feldspathic in nature, while the other component of mine spoil is shale which is more or less carbonaceous in nature. Small amount of low grade coal is also mixed with the spoil.

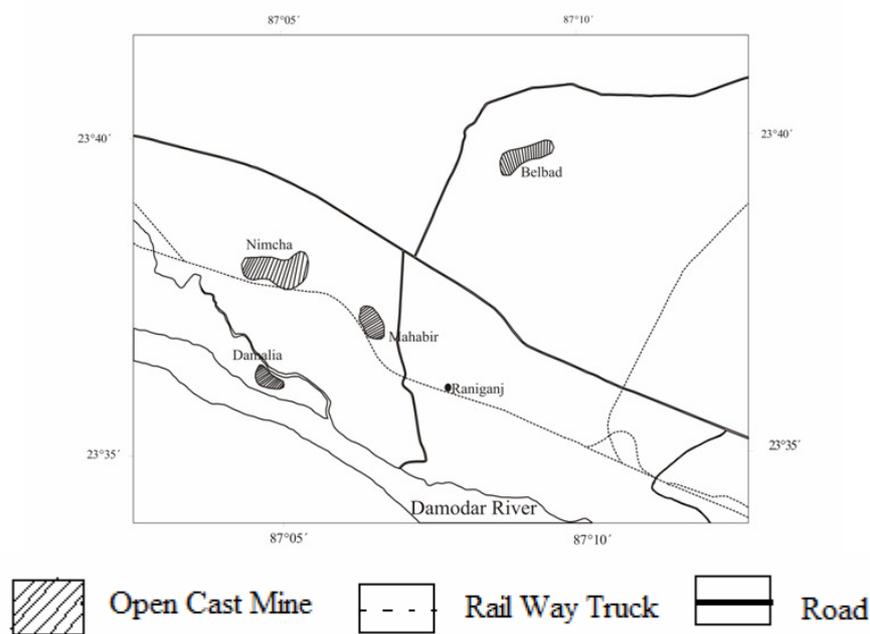


Figure 1: Study area

#### 1.4 Vegetation of the area

The native vegetation around the mining area is typically mixed dry deciduous forest with plants like *Shorea robusta*, *Terminalia tomentosa*, *Butea monosperma*, *Dalbergia sissoo*, *Madhuca indica*, *Terminalia arjuna* and *Azadirachta indica*. *Dalbergia sissoo* and *Butea monosperma* have been found to be most frequent plants among the woody species and *Lantana camara* and *Eupatorium odoratum* are dominant among the shrubs grown on mine spoil. Major herbaceous species on these spoils have been found to be *Saccharum spontaneum*, *Eragrostis tenella*, *Dicanthium annulatum*, *Cynododon dactylon* and *Desmodium trilorum*. Other vegetations of the study area are given in table- 1.

Table 1: Primary vegetation cover of mine soil and their respective native forest soil in Raniganj coal field during august 2010-2011

Sl No.	Scientific Name	Common name	Family
Tree species			
1	<i>Dalbergia sissoo</i>	Sisum	Legminoseae
2	<i>Azadirachta indica</i>	Neem	Meliaceae
3	<i>Albizia procera</i>	Siris	Legminoseae
4	<i>Delonix regia</i>	Gulmohr	Caesalpiniae
5	<i>Acacia Arabica</i>	Babla	Legminoseae

6	Leucena leucocephala	Subabool	Legminoseae
7	Pithocelobum duke	Jangli jalebi	Legminoseae
8	Sizygium cumini	Jam	Myrtaceae
9	Zizyphus mauritina	Kul	Rhamnaceae
10	Terminalia arjuna	Arjun	Combretaceae
11	Gamelia arborea	gamar	
12	Acacia auriculoformis	Akashmani	Mimosaceae
Herbs species			
1	Saccharum spontaneum	Kans grass	Poaceae
2	Erogrostis tenella	Bug's egg grass	Poaceae
3	Dicanthium annulatum	grass	Poaceae
4	Cynododom dactylon	Bermuda Grass	Poaceae
5	Desmodium trilorum	three-flower beggarweed	Fabaceae
Shrubs species			
1	Leonotis naptifolia	Lion's Ear	Lamiaceae
2	Lantanna camara	Wild sage	Verbanaceae

## 2. Sample collection and methodology

Mine spoils were collected from unreclaimed overburden dumps and nearest native soils were collected from the surroundings of open cast mines where local vegetation is already established. The overburden mine soils are collected by random grid method of 10 m x 10 m grid. One composite sample has been collected from each grid, by mixing of eight sub-samples and reducing the weight to approximately 500 gm by conning and quartering method. The samples are packed in polyethylene bags and assigned a number.

In case of the native soil, the soil samples were collected from the rizosphere of the planted tree species. The collected samples were then air dried at room temperature (30 to 35 degree centigrade) in the laboratory and lightly crushed with mortar-pastel and passed through 2 mm sieve. The mine spoil and native soil samples were analyzed for the physico-chemical properties by standard procedure as presented in table-2.

**Table 2:** Standard procedures adopted for dump material and native soil for testing

Variable parameter	Procedures	Reference
Physical Parameters		
1. Grain size distribution	Sieve analysis	Jumkins (1965) <sup>20</sup>
2. Moisture content	Measurement of weight	Desai (1986) <sup>21</sup>
3. Bulk density	Excavation method	Black (1965) <sup>22</sup>
4. Specific gravity	Pycnometer	Desai (1986) <sup>21</sup>
5. Porosity	Measurement of weight and volume	Jumkins (1965) <sup>20</sup>
6. Water holding capacity	Keen's box	Black (1965) <sup>22</sup>
Chemical Parameters		
1. pH	Glass electrode	AWWA (1992) <sup>23</sup>
2. Electrical conductivity	Glass electrode	AWWA (1992) <sup>23</sup>
3. Organic carbon	Walkley-Black method	Jackson (1958) <sup>24</sup>
4. Available-N	Jackson (1958)	Bremner (1965) <sup>25</sup>
5. Available-P	Olsen method	Sparling et al. (1985) <sup>26</sup>

6. Available-K	Olsen method	Jackson (1958) <sup>24</sup>
7. Cation exchange capacity	Sodium acetate method	IS 2720, Part XXIV <sup>27</sup>
8. Exchangeable cation	Ammonium acetate method	Trivedy (1987) <sup>28</sup>
9. Heavy metals analysis	Soil digestion methods	USEPA (1996) <sup>29</sup>

### 3. Result and discussion

Altogether eight numbers of composite samples, two each from Belbad, Damalia, Nimcha and Mahabir coal mine areas were collected during 2010. Out of two samples in each coal mine area one sample is the representative of mine spoil and the other represents the surrounding native soil.

Sample no BM1 and BS1 represent the mine and native soil respectively of Belbad Colliery, DM1 and DS1 represent those from the Damalia colliery, NM1 and NS1 represent the samples from Nimcha colliery and MM1 and MS1 represent the Mahabir colliery. The physical as well as chemical properties of these samples are represented colliery wise in tables 3, 4 and 5.

#### 3.1 Physical characteristics and comparison of native soil to mine spoil

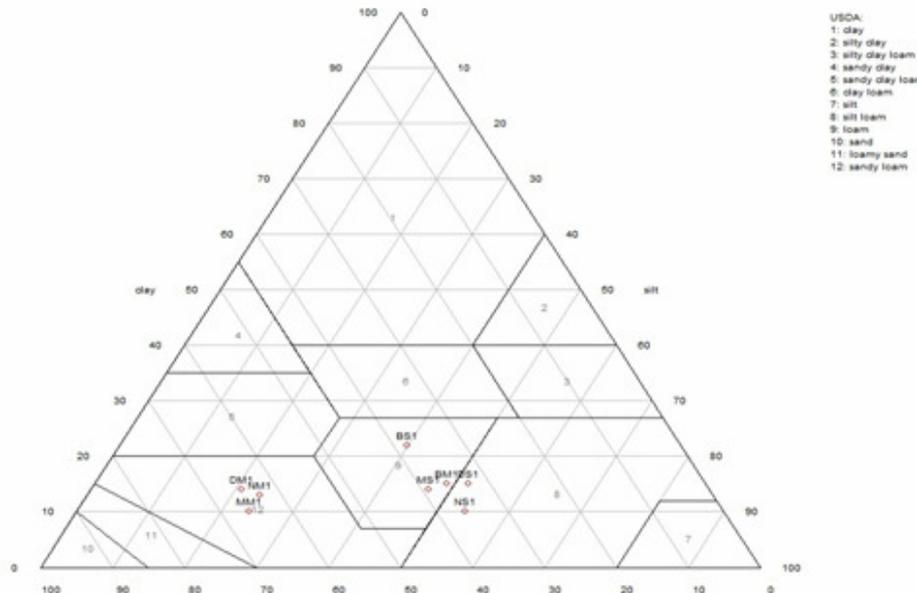
##### 3.1.1 Soil texture

The results of present study reveal that sand particle increases whereas silt and clay particles decrease in mine spoils with respect to native soil (table 3). There is no appreciable difference in sand content between the mine spoil (BM1) and surrounding native soil (BS1) of Belbad mine, where as a perceptible difference in sand and silt content between the mine spoil and the surrounding native soil in each of the other mine areas have been noticed. Belbad, being the oldest mine among these four, might have suffered sufficient weathering and erosion and through a dynamic equilibrium a more or less homogenization is achieved between the mine spoil and surrounding native soil. The mine spoil of the other three mines show sandy loam texture which is distinctly different from silty loam texture of the respective native soils. According to Noy-Meir, 1973, in relatively dry and intermediate climates, the region of minimum sufferance is the 'sand region', while for the relatively wet climate the most favorable soil texture is the 'silty loam region'. The present study reveals that open cast mine changes the soil texture from silty loam to loamy sand texture which has direct impact on climate. If this trend continues in future, the region may gradually change from generally wet climate to dry intermediate climate resulting into desertification.

**Table 3:** Mechanical analysis and textural class of mine soil and their respective native soil in Raniganj coal field during august 2010-2011

S No	Sand (%)	Silt (%)	Clay (%)	Texture type
BM1	36	49	15	Loam
BS1	38	40	22	Loam
DM1	65	21	14	Sandy loam
DS1	33	52	15	Silt loam
NM1	63	24	13	Sandy loam
NS1	36	54	10	Silt loam
MM1	66	24	10	Sandy loam
MS1	39	47	14	loam

According to the particle size classification, soil textures of the mine spoil are mainly found as sandy loamy type and native soil are silty loam type (table-3). The silty loamy type soil is the indicator of availability of water and nutrients to the plant root system and thereby affecting the plant growth and sandy soil holds less water and nutrients which affect the plant growth in investigation area. Results of all the eight samples are shown in (figure 2).



**Figure 2:** Soil texture classification of mine soil and their respective native soil in Raniganj coal field

### 3.1.2 Soil moisture

Soil moisture is very much important for hydrological, biological and biogeochemical processes. Soil moisture is a key variable in controlling the exchange of water and heat energy between the land surface and the atmosphere through evaporation and plant transpiration. Average field moisture of all the mine spoil was found 4.28 percent which is lower than native soil 7.83 percent (table-4). Minimum average field moisture required 5 percent sufficient growth for the plant. The field moisture content in a mine spoil is a fluctuating parameter which depends on time of sampling, height of dump, stone content, and amount of organic carbon, texture and thickness of litter layers (Maiti, 2006b). Low moisture content in the mine spoil may be attributed due to lack of organic matter, higher stone content and sandy texture.

### 3.1.3 Water holding capacity

The amount of water holding capability in soil is one of its important characteristics. It rise in soil when soil texture moves from sand to clay. In Belbad areas native soil and mine spoil sand content are more or less same but clay content are found high in native soil, so it has been noticed that water holding capacity also be high in native soil. Other mine areas such as Damalia, Nimcha and Mahabir, silt content of native soil texture are higher than their respective mine spoil. So, water holding capacity is also found higher in native soil. The average value of water holding capacity in mine spoil is 41.82 percent and native soil is 50.41 percent.

### 3.1.4 Particle density

Particle density is also a major factor in governing successful vegetation and influences water holding capacity, bulk density, soil moisture availability and nutrient content as well as its availability. In the study area average particle density of native soil is 2.37 g/cm<sup>3</sup> and in mine spoils 2.51 g/cm<sup>3</sup> respectively.

### 3.1.5 Soil porosity

Soil porosity attributes to the fragmentation, redistribution and aggregation of the particles due to vegetation development. The total pore volume of the soils at the mine spoil sites is 2.85 to 7.61 per cent lower compared with the native soil sites (table-4) as a cause of mining areas mainly opencast mine causes deforestation, has a reduction of pore volume of the soil at the investigation site. A reduction of the volume of macropores has a direct negative effect on infiltration capacity and soil moisture content thus encouraging soil erosion (Bork 2006). The macropore volume decreased as a result of soil compaction due to tillage and trampling by humans coupled with a decline of the soil organic carbon content in the mine spoil (Yimer F, et al., 2008). The increasing organic matter may also have contributed to the overall improvement in porosity in native soil (Gairola et al., 2010).

### 3.1.6 Bulk density

Bulk density is an another important property for gaseous exchange, such as high bulk density would pose restriction to the growth of deeper rooted plants and may be one of the reasons of cessation of plant growth (Ghose et al., 2004). Bulk density of mine spoils is comparatively higher as compared to the native soil (table 4), as dumping sites in the mine areas are evidently influenced by the use of machinery (Maiti, 2006b).

**Table 4:** soil physical properties of mine soil and their respective native soil in Raniganj coal field during august 2010-2011

S No	WHC (%)	Moisture Cotent (%)	BD (g/cm <sup>3</sup> )	PD (g/cm <sup>3</sup> )	Porosity (%)
BM1	42.53	5.27	1.47	2.53	41.78
BS1	54.64	9.04	1.25	2.28	45.22
DM1	37.57	3.21	1.39	2.47	43.61
DS1	45.72	7.57	1.34	2.34	44.89
NM1	43.02	4.78	1.25	2.51	50.2
NS1	49.26	7.21	1.11	2.4	53.78
MM1	44.18	3.88	1.25	2.55	51.04
MS1	52.02	7.50	1.19	2.49	52.25

## 3.2 Chemical characteristics and comparison of native soil to mine spoil

### 3.2.1 Soil pH

pH is an important index of ecological condition of terrestrial environment (Rai et al., 2011). The pH value recorded in the study area varies from 8.02 to 8.61, which are basic in nature. In native soil pH is more than those of fresh mine spoil. The increase in pH in native soil is probably due to organic matter input that modifies the pH of the soil (Banerjee et al., 2004). Since, the plant species are mostly dictylenous, these may release more base cation like Ca, Mg into the soil, which increases the pH of the soil (Richardson et al., 1971).

### **3.2.2 Soil Exchangeable cation**

Exchangeable cations are adsorbed on the soil surface which can be exchanged with other cations held in solution. The improvement in the exchangeable calcium concentration indicates improved spoil physical properties (Wilson et al., 2002). The mine spoils of the study area contains good amount of feldspar in the soil constituents. Feldspar, being susceptible to weathering, easily releases cations like Ca, Mg, K and Na into the solution. As a result, more and more cations will be derived from the soil with time and pH of the soil solutions will show progressive alkaline character. The concentration of these cations in native soil is higher than the mine spoil (table-5 a). Soil solution pH is dependent on mineral weathering and mineral weathering increases pH by releasing Ca, Mg and K into the solution. Native soil pH content around Belbad and Damalia are higher than other two areas. So it is found that in these two areas exchangeable cations (Ca and Mg) are found both high.

### **3.2.3 Electrical Conductivity**

Overall electrical conductivity of the samples of the study area is low (table-5 a). Conductivity in natural soils varies between 200 to 800  $\mu\text{s}/\text{cm}$  is required for optimum plant growth (Beer, 1964). Low electrical conductivity indicates lower concentration of other parameters like bulk density, organic matter, exchangeable cation etc. In Mahabir ares, higher electrical conductivity than other three areas implies higher concentration of other cations like Ca, Mg.

### **3.2.4 Cation exchange capacity**

The mineral fertility of the soil depends on cation exchange capacity as the cations are contained in a form in which they are not easily leached by water. Sandy soil has low exchange capacity and consequently has low fertility. In the study area mine spoils are more or less sandy type where cation exchange capacity is lower than their respective native soils which are mostly silty-loam type. This result also suggests that low cation exchange capacity has reduced water holding capacity, soil organic carbon and nutrient properties of the soil (Bahrami et al., 2010).

### **3.2.5 Organic Carbon**

The total content of soil organic of the mine spoil soil was significantly lower than the organic carbon content of the native soils (39 to 56 per cent less, Table 5 b). The main sources of organic carbon in native soil are plant debris-dead roots and rhizomes and the surface litter or dead leaves. The soil organic carbon plays a major role in biological activity and fertility of the soil. Higher organic carbon increases the soil porosity that supports the growth of the soil microorganisms. The lower level of organic carbon in mine spoils causes disruption of the ecosystem functioning (Stark, 1977) and depletion of organic pool (Parkinson, 1979). Another cause of organic carbon decreases is that in O.C.P areas tree species are also absent, so lack of humus content results less organic carbon content in spoil than their respective native soil.

### **3.2.6 Available nitrogen**

The change of total nitrogen content (table 5 b) followed a similar pattern as the organic matter change. The nitrogen a content of the mine spoil site is that 62.7 to 86.3 per cent lower compared with the native soil sites (table 5 b). Since most soil nitrogen is bound in organic

matter in the native soil areas thus the result was expected (Khresat, 2008). In native soil available nitrogen is more due to litter fall and microbial activity causing transformation of inorganic forms around roots of plant species. Another reason in mine spoil is the removal of natural vegetation, destroys its natural conditions leads to the loss of large amounts of nitrogen from soil surface (Aghasi et al., 2011).

### 3.2.7 Available Phosphorus

Phosphorus plays a role in the photosynthesis, respiration, energy storage and transfer, cell division, cell enlargement and several other properties in the living plant. Available Phosphorus present in mine spoils is in the range of 2.69 to 3.21 and that in native soils is between 4.65 and 5.64. In native soils, clay particle content is higher than mine spoils and high clay content will fix more phosphorus than sandy soil (table 3 & 5 b). Moreover, compaction reduces aeration and pore space in root zone of the plants. This reduces root growth and, therefore, phosphorus uptake is unavailable form for native soil.

### 3.2.8 Available potassium

Potassium content of the mine spoil sites is 19.5 to 38.9 per cent lower compared with the native soil sites (table 5 b). It has been estimated that available potassium of 100 ppm is sufficient for plant growth, 50-100 ppm indicates its moderate deficiency and 0 to 50 ppm available potassium indicates its high deficiency for plant growth (Gammel, 1990). In the study area of mine spoils, available potassium are indicating high deficiency level whereas native soils show moderate to low range of available potassium.

**Table 5:** Chemical and nutritional properties of mine soil and their respective native soil in Raniganj coal field during august 2010-2011 (a) pH, EC and Exchangeable part (b) Available nutrients, organic C and CEC

S No	PH	EC ( $\mu\text{s}/\text{cm}$ )	Exchangeable cation			
			Ca $\text{mg kg}^{-1}$	Mg $\text{mg kg}^{-1}$	Na $\text{mg kg}^{-1}$	K $\text{mg kg}^{-1}$
BM1	8.32	188	37.52	13.59	1.05	5.14
BS1	8.61	264	68.74	23.81	5.99	7.79
DM1	8.24	206	45.57	15.56	12.79	6.65
DS1	8.54	296	67.16	23.33	28.43	7.3
NM1	8.28	172	32.74	16.99	2.6	2.84
NS1	8.42	236	47.16	18.47	16.19	6.79
MM1	8.07	330	60.74	30.13	30.77	6.29
MS1	8.32	390	64.74	33.53	37.29	9.85

(a)

S No	Available nutrients			Org C %	CEC C $\text{mol}/\text{kg}^{-1}$
	N $\text{mg kg}^{-1}$	P $\text{mg kg}^{-1}$	K $\text{mg kg}^{-1}$		
BM1	37.78	3.21	44.15	0.32	4.79
BS1	110.1	5.64	54.86	0.84	7.59
DM1	33.34	2.89	38.74	0.34	4.83
DS1	89.34	4.65	63.43	0.73	6.9
NM1	16.64	3.14	27.28	0.27	5.18
NS1	121.72	4.98	41.91	0.75	7.02
MM1	23.38	2.69	32.06	0.3	4.95
MS1	96.45	4.28	46.06	0.86	6.68

(b)

### 3.3 Trace metal content

There have been no significant differences noticed about the trace metal in the investigation site in mine spoil and native soil (table-6). The concentration of acid extractable total metals such as Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Ti, Zn in mine spoil and native soil are given in Table 6. Among the metals, Fe had the highest mean concentration (21.8 g/Kg in mine spoil, 20.8 g/Kg in native soil), while the lowest value was for Cd (0.97 mg/Kg obtained in both mine spoil and native soil). The mean concentrations of other metals were 12.3 mg/Kg and 12.2 mg/Kg for Co, 49.5 mg/Kg and 43.9 mg/Kg for Cr, 12.9 mg/Kg and 11.5 mg/Kg for Cu, 386.24 mg/Kg and 538.50 mg/Kg for Mn, 25.66 mg/Kg and 26.82 mg/Kg for Ni, 216.56 mg/Kg and 106.88 mg/Kg for Ti, and 39.71 mg/Kg and 40.73 mg/Kg for Zn in mine spoil and native soil respectively.

**Table 6:** Trace element of mine soil and their respective native soil in Raniganj coal field during August 2010-2011

	Mine Spoil		Native Soil	
	Min.	Max.	Min.	Max.
Cd (mg/Kg)	0.73	1.1	0.8	1.08
Co (mg/Kg)	9.60	14.55	10.6	14.22
Cr (mg/Kg)	32.87	66.23	31.87	56.97
Cu (mg/Kg)	6.63	17.25	8.4	15.68
Fe (g/Kg)	14.78	35.46	16.09	30.91
Mn (mg/Kg)	343.63	477.06	475.81	621.26
Ni (mg/Kg)	20.27	31.09	19.01	35.22
Pb (mg/Kg)	0.00	7.79	8.16	9.82
Ti (mg/Kg)	125.16	333.48	21.09	153.7
Zn (mg/Kg)	27.01	47.47	36.6	44.76
Mo (mg/Kg)	26.72	45.63	34.01	56.61

### 4. Conclusion

Due to extensive exploration of coal in Raniganj coal fields, topography including soil in a great extent creating unfavorable conditions in mine areas for plant habitat. Mining of coal also causes massive damage to landscape and biological community. It has been found that there were a number of tree species, herbs and shrubs, but their numbers have greatly reduced due to mining activity. The soil quality change from silty loam to sandy loam not only affects vegetation but also plays a vital role in changing the local climate. Other physical properties of soil i.e. water holding capacity, soil moisture etc. are lower in mining areas than native soil. Soil nutrients like available nitrogen, available phosphorus and available potassium also are lower in mining areas with respect to native soils. In native soils, the average value of organic carbon is much higher than mine spoils suggesting that the mining activities have definitely damaged the quality of soil. Cation exchange capacity is also disturbed by mining activity as compared to their nearest native soil.

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