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Effect of coal mining activities on the vegetation composition of Sarubera Colliery of Ramgarh District, Jharkhand

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Abstract- Extraction of Mineral resources brings internal and external benefits to the country. Coal mining also generates revenue and creates employment. But a big cost is being paid to these mining activities in terms of vegetation clearance. The volume of dust released by coal mining degrades the soil supporting the plant. It impairs the photosynthetic and fruiting ability of plants. In this study biodiversity indices were employed to investigate the effects of mining activities on the vegetation composition within the mining area and 5 km away from mining site. A total of 84 individual belonging to 34 families were recorded in the study. In which 57 individuals belonging to 24 families were found growing in the overburden dump area. Among these 20 trees, 17 shrubs and 42 species were encountered. Shannon and Simpson Diversity Index, Margalef species Richness and Pielou's species evenness index were also found to be more at unmined area than in mined area.

Key words: Relative humidity, Incubation, Fungal incidence, Quality deterioration

INTRODUCTION

Coal a fossil fuel which is valued for its energy content and since the 1880s has been widely used to generate electricity. Industries use coal as a fuel for various purposes like steel, iron ore extraction, thermal energy production etc. While valuable to human energy production, it is nevertheless difficult expensive and dangerous to obtain with high cost to the environment and human health. There is a debate whether the environmental effect of coal mining justify its use as the process contributes a high level of damage to the environment.[1] The exploitation and utilization of coal resources have been lasting for thousands of years, resulting in a series of ecological environmental problems. So far, the mining area has changed into severe and typical damaged ecosystem.[2] It results in slowing of the rate of biomass growth, which is caused by fading of vegetation. Simultaneously, carbon stored in vegetation is constantly released, weakening vegetation ability to act as a carbon sink. Indirect release of carbon during coal mining processes is difficult to measure and is often neglected in carbon accounting.[3]

Vegetation of a place reflects a wide variety of environmental characteristics as well as temporal aspects operating on it.[4] It also supports critical functions in the biosphere by regulating the flow of numerous biogeochemical cycles like that of water, carbon, and nitrogen. It is also of great importance in local and global energy balance. Removal of vegetation cover strongly affects soil characteristics, including soil fertility,

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chemistry and texture. Although vegetation is of high environmental and biological importance, it is often under intense human pressure in mining areas especially where surface mining and illegal small scale mining activities are prevalent, resulting into changes in land-use/land-cover of mine areas. Directly or indirectly, mining has been seen to be a major factor responsible for vegetation loss in mining areas the world over.[5] Directly, it is caused by vegetation clearance for various mining activities and indirectly, with dust pollution as volume of dust is discharged into the air during the process of quarrying. This eventually gets deposited on the leaves of plants and flowers as well as the soil supporting the plants. The overall effect of this is that the photosynthetic and fruiting ability of the plants is impaired.[6]

Loss of vegetation is not just region specific; it is a global challenge and can be attributed to different occurrences in land use, human activities as well as climate changes.[7] Vegetation plays an important role in improving and restoring fragile ecological environments. It is crucial to understand the effects of soil and topographic factors on vegetation restoration to improve the fragile ecosystems of damaged land.[8]

Coal mining activities are known to mainly affect the local vegetation from the following perspectives: mining activities cause surface subsidence and changes to cracks in the ground and surface micro topography that alter the growth environment of vegetation's roots; burning of gangue hill and underground coal fire causes large areas of vegetation to fade or die. Soil physical and chemical properties changes which hinders nutrient absorption by the vegetation.[9] The aim of this work is to study the effect of coal mining on vegetation of the area.

MATERIAL & METHOD

Area into consideration:

Sarubera Coal mines situated in Ramgarh District of Jharkhand (Latitude-23.62833 N; Longitude-85.521111 E)

Sarubera is a colliery of Central Coal Fields Limited, a subsidiary of Coal India Limited. It has underground (UG) as well as open cast mines. Sarubera area is surrounded by Ara colliery of CCL from one side, Tata colliery in West Bokaro zone and Chainpur Tata project site from the other sides. Vegetation present in this stretch of area was studied for its diversity, species richness and evenness. These studies were done both on the overburden dump area and the adjacent site 5 km away from it.

METHOD AND DATA COLLECTION

To assess the vegetation composition, two areas where purposely selected, vegetation growing on overburden dump area and the vegetation within the adjacent site 5-7 km away. Five plot of 10m ×10m were demarcated. This was further demarcated into two sub plots of size 5m × 5m. Within these 5m × 5m plots smaller quadrant of 1m × 1m was demarcated in both the 5m × 5m plot and one outside it as shown in the Figure 1.

Such demarcation for quadrant study was done in both overburden dump area and the adjacent area 5 km away.

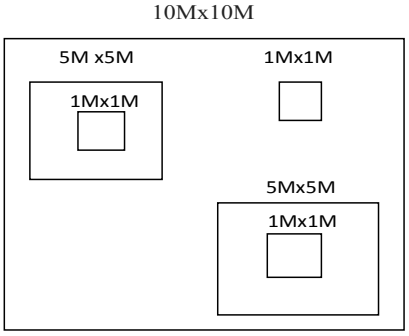

Fig. 1

Data Analysis for Vegetation Cover

Floristic compositions in the two sites were estimated using diversity indices such as species richness, diversity and evenness. Species richness was computed using Margalef (1951)[10] as cited by Spellerberg (1991)[11] and Magurran (2004)[12].

It is measured by the formula: $D = \frac{S-1}{ln N}$

Where,

D = species richness index (Margalef index),

S = number of species and

N = the total number of individuals.

Species diversity was estimated using Shannon-Wiener Diversity Index as cited by Spellerberg (1991)[11]; Turyahabwe and Tweheyo (2010)[13]; Ruszczyk *et al.* (1992)[14] cited by Radha *et al.*(2016)[15].

Shannon-Wiener Diversity Index equation is stated as:

$$H' = -\sum_{i=1}^{s} pi \; ln \; pi$$

Where,

H' = species diversity index,

pi = the proportion of individuals or the abundance of the ith species expressed as a proportion of the total abundance.

The use of natural logs is usual because this gives information in binary digits.

Species evenness was estimated using Pielou's evenness (equitability) index (Pielou, 1975)[16] cited by Turyahabwe and Tweheyo (2010)[13] as followed:

$$J' = \frac{H'(\text{observed})}{H_{max}}$$

Where,

J' = Pielou's evenness index

H' (observed) / H_{max}

H_{max} is the maximum possible diversity, which would be achieved if all species were equally abundant (=Log S)

The indices were computed for all plant species in various growth forms (trees, sapling, shrubs and herbs) in each plot of vegetation location.

RESULT

In this study, a total of 20 trees, 17 shrubs and 42 herbs species were encountered. In the over burden dump (OBD) area 10 trees species belonging to 3 families were encountered. Among the shrub community, 13 shrub species belonging to 6 families were found in OBD area. A total of 34 herbaceous species belonging to 15 families were found in the same area. Species richness (Marglef Index value) in the coal refusal dumping site recorded a lower value of D=2.843. A lower species richness value was recorded for trees, D=1.986, shrubs=2.446 and herbaceous community D=4.093 as well.

Shannon Wiener Diversity Index was found to be less in over burden dump area with H'=2.39. For plants community growing in over burden dump area, a lower value was recorded for trees. H'=1.86, shrubs=2.449 and for herbaceous community, it was found to H'=3.220.

Simpson Diversity Index in the OBD area recorded a lower value D=0.551. For trees D=0.571, for shrubs D=0.49 and for herbaceous community D=0.583 which was lower than the unmined area.

Pielou's species evenness index was found to be lower in the overburden dump area where H'=0.716. Tree species evenness index in the mined area was 0.577, for shrubs it was 0.7388 and for herbs it was 0.8617.

In the adjacent undisturbed site away from the mining activities, 25 trees belonging to 12 families, 17 shrubs belonging to 7 families, 42 herbaceous species belonging to 15 families were encountered. Species richness value (Marglef Index) also show a higher value in the adjacent site with D=4.003. Marglef species richness index for trees was 4.6678, for shrubs 2.44 and for herb it was 4.55.

Even Shannon Diversity Index was found to be higher in unmined adjacent area with H'=2.903. For the trees community, it was 2.872 for shrubs it was 2.449 and for herbs it was 3.885. Similarly, Simpson Diversity Index was found to be more in the unmined area with D=0.553. For tree community, Simpson Diversity Index was found to be D=0.5768, for shrubs it was 0.5024 and 0.609 for herbaceous community. Pielou's species evenness index recorded a higher value in the unmined area with H'=0.88. Tree species evenness index in the unmined area was 0.892, for shrubs it was 0.847 and for herbaceous community it was 0.905.

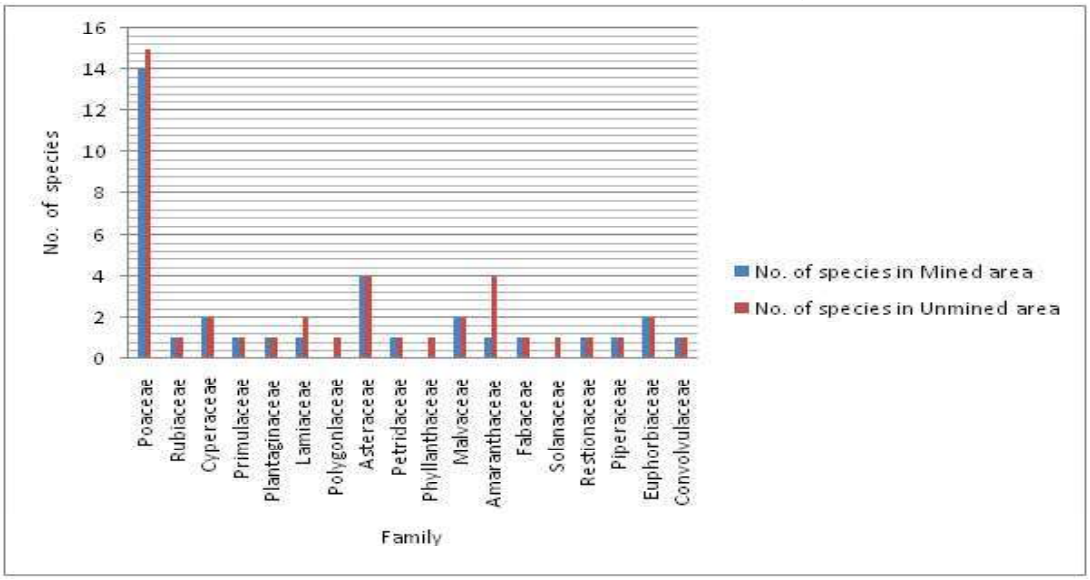

Fig 2 : Frequency of family growing in mined and unmined area among the Herb Community

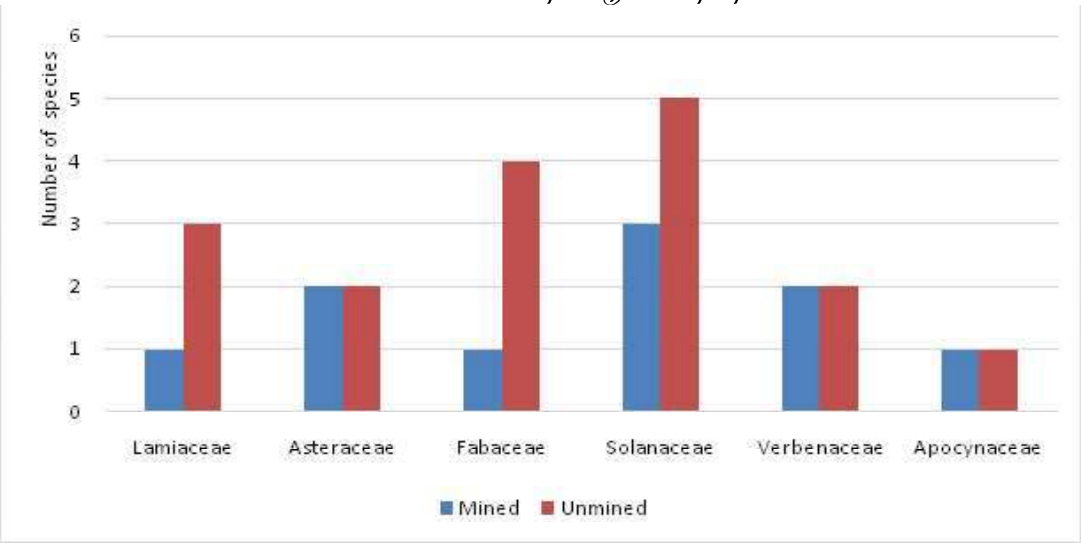

Fig 3: Frequency of family growing in mined and unmined area among the Shrub Community

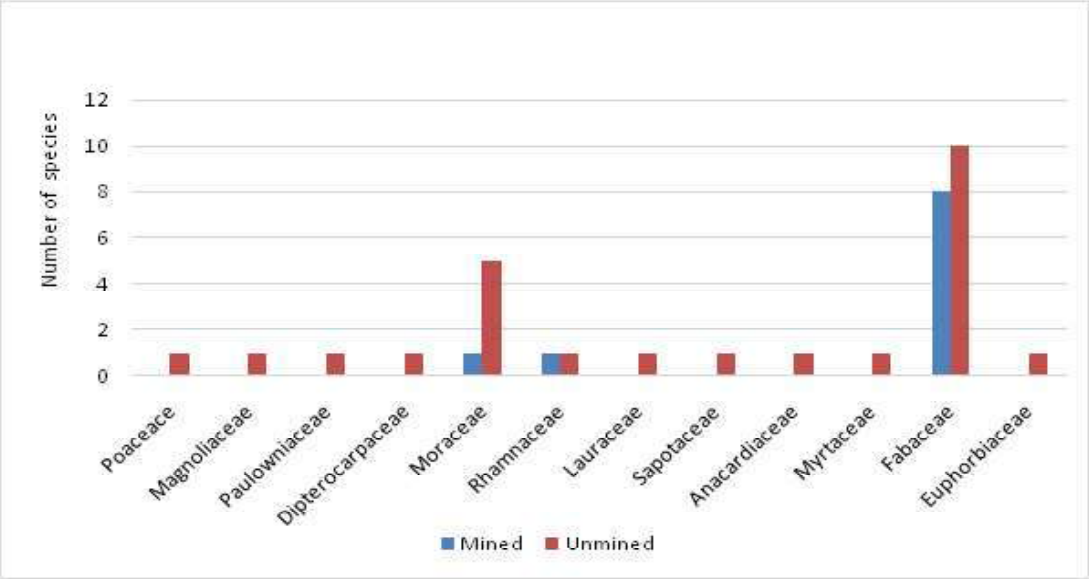

Fig 4: Frequency of family growing in mined and unmined area among the Tree Community

DISCUSSION

A total of 84 individuals belonging to 37 families were recorded in the study, in which 57 individuals belonging to 24 families were found growing in the overburden dump area. The overburden dump degrades the soil quality and disturbs the vegetation growing there. The value of the Simpson Diversity Index was found to be more in the adjacent unmined area than the OBD area. The coal refusal soil is not supporting much of the plant species to thrive.

A Shannon Diversity Index value near 4.6 indicates that the numbers of individuals are distributed evenly. It rarely surpasses a value of 4.5. The Shannon Diversity Index obtained in the study was reported to fall between 1.5 and 3.5 which indicates a disturbed distribution of vegetation.[15]

Species evenness ranges from 1 to 0, where 1 indicates complete evenness and 0 as no evenness. The two sites from our survey show no evenness in species composition. This might be because of the mining activities which has altered the vegetation composition. Pielou's species evenness indexes show that the unmined adjacent area recorded a higher value than the overburden dump area.

In open cast mining the, overlying soil is removed and fragmented rock is heaped in the form of overburden dumps.[17,18] This dump materials are left over occupying a

large area of land, due to which land loses its original use and the soil quality is degraded.[19,20] As the dump materials are generally loose, the fine particles become highly prone to blowing away by wind. These get settled over the surrounding fertile land and disturb their natural quality and growth of plants especially the fresh leaves. Dust deposition on the leaves of plant is capable of blocking the stomata pore, thereby hindering transpiration resulting in decrease in Biomass production. It may lead to reduction in growth of certain species that could not survive on the degraded soil.

It has been found that overburden top materials are usually deficient in major nutrients. Thus, the open cast coal mining particularly release a huge amount of mining waste to the upper part of the soil surface as OBD materials which raises a number of environmental challenges, including soil erosion, dust, water pollution, loss of nutrients qualities and microbial activities of the soil system and ultimately impacts on the floral diversity.[21]

Poaceae is the most abundant family found in the herbaceous community and *Grona triflora* of the Fabaceae family was the most abundant species found to be growing in the over burden dumping site among the herbaceous community. *Cynodon dactylon, Oplismenus hirtellus* were few other abundant species (Fig. 1).

Tephrosia purpurea of the Fabaceae family was found to be the most abundant among the shrub community in the overburden dump area (OBD)(Fig.2) *Rhizobium* bacteria grow in the root nodules of the plants of Fabaceae family which fix atmospheric Nitrogen and help in increasing soil fertility. The residues of this nitrogen rich leguminous plant stimulates earthworm burrows which in turn increases soil porosity, movement of air and water to deeper soil depths. Furthermore, Fabaceae family have extended value because they are naturally high quality forage that could enhance the quality and productivity of associating species specially grasses by biologically fixing atmospheric Nitrogen.[22,23] *Acacia auriculiformis* was the most abundant tree found growing in the over burden dump area followed by *Senna siamea* both of fabaceace family (Fig.3)

Most of the soil reclamation of over burden dump area is being done by the district forest department in association with CCL and TATA Coal Mining Project of West Bokaro. Surface Mining Control and Reclamation Act (SMCRA) of 1977 have recommended the use of native grass and legume species in mine degraded areas. Thus, the trees being planted for reclamation are mostly of Fabaceae family.[23]

In order to gain information of the flora of the study area before the beginning of work, local villagers were interviewed. They identified trees like *Dalbergia sisso, Madhuca longifolia, Butea monosperma, Shorea robusta, Bumbusa vulgaris, Tamarindus indica, Zizipus jaozerio, Ficus racemosa, Mangifera indica, Actocarpus heterophyllus* growing earlier in these areas.

CONCLUSION

Plant diversity is widely affected due to the mining activities. Biodiversity indices were employed to investigate the effect of mining activities on the vegetation composition within the mining area and 5-7 km away from the mining site.

Mining activities releases a lot of mining wastes on the soil surface. This degrades the soil quality and affects the soil microbial diversity as well as the floral diversity growing in that area. This was revealed through the studies undertaken which shows diversity indices of Shannon and Simpson to be less in mined area than the unmined area.

Biodiversity indices like Marglef species richness and Pielou's species evenness was also found to be less in these mined areas as compared to the unmined area. Thus, from the study it can be concluded that mining truly has affected the vegetation composition of the place. Reclamation work is also being done to compensate the loss by planting leguminous plant which helps to increase the soil fertility and help in support in the growth of other associated species.

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