Eurasscience Journals

Eurasian Journal of Forest Science (2017) 5(1): 1-7

IMPACT OF MINING ON HERBACEOUS GROUND COVER AND WILD FAUNA IN BIRSHA- DAMOH FOREST RANGE OF MALANJKHAND COPPER MINES OF INDIA

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Abstract

Mining is known to demolish adjacent natural ecosystem all over world with generating massive volumes of wastes dumped resulting in damage to the natural ecosystem, reducing herbaceous ground cover and wildlife. Hinustan Copper Mines (HCM) is the Asia's largest open cast copper mines and produces 70 % copper for the Indian market. The study was carried out at buffer zone of HCM in 31 forest sites of Birsha-Damoh forest range area of Balaghat district of Madhya Pradesh in India. The herbaceous ground cover (HGC) was estimated by line transect method. Results indicated that the total average herbaceous ground cover ranged from 11.2 - 77.44%, indicating least wildlife movement at site 14 and maximum at site 29. The dominant herbaceous plants were *Cynodon dactylon* followed by *Lantana camara, Thysanolaena maxima* covering across most of the sites. The rest of the herbaceous species were *Vallaris heyne, Achyranthes aspera, Eragrostis tenella, Waltheria indica* and *Ocimum Gratissimum,* found as casual constituents of the community. The maximum number (7) of wild animals presence in a day was observed at *Cynodon dactylon* and *Thysanolena maxima* dominated sites and minimum number (1) was observed at *Lantana camera* dominated forest sites.

Keywords: Ground cover, herbaceous layer, Hindustan Copper mines, wild fauna.

Özet

Madencilik faaliyetleri sonucu açığa çıkan yüksek miktarda dolgu malzemesinin doğal alanlara atılması ile tüm dünyada doğal ekosistemlerde yıkıcı sonuçlar oluşmakta, bitki örtüsü ve yaban hayatı tahrip edilmektedir. Hinustan Bakır Madenleri (HBM) Asya'nın en büyük açık maden ocağı işletmelerinden olup, Hindistan'daki pazarın %70'lik payını üretmektedir. Bu çalışma HBM'nin tampon bölgesinde yer alan 31 Birsha-Damoh ormanında (Balaghat-Madhya Pradesh-Hindistan) gerçekleştirilmiştir. Ot tabakasındaki bitki türleri (OBT) çizgisel nokta yöntemi ile belirlenmiştir. Sonuçlara göre OBT %11.2-77.44 arasında değişmiş ve en düşük yaban hayvanı dolaşımı 14 ve en yüksek 29 numaralı alanlarda olmuştur. En baskın OBT türü *Cynodon dactylon* olup bunu *Lantana camara, Thysanolaena maxima* türleri izlemektedir. Alanda bulunan diğer türler ise *Vallaris heyne, Achyranthes aspera, Eragrostis tenella, Waltheria indica* ve *Ocimum Gratissimum* türleridir. Belirli bir alanda en yüksek sayıda yaban hayvanı bulunuşu *(7) Cynodon dactylon* ve *Thysanolena maxima* hâkim alanlarda bulunmuş, en düşük ise (1) *Lantana camera* yaygın olan orman alanında bulunmuştur.

Anahtar kelimeler: Diri örtü, otsu tabaka, Hindustan bakır madeni, yaban hayatı.

INTRODUCTION

India is emerging as net exporter of copper from the status of net importer on account of rise in production by three companies namely Hindustan Copper Mine (HCM), Hindalco and Sterlite industries Ltd. Presently Indian copper industry produces 4 lakh ton which has 3% of the world copper market (http://www.indianmirror .com) and its 70 % alone produced by HCM (CSIR- CIMFR 2012).

Mining is known to demolish the natural ecosystem adjacent to mining site all over the world and it generate massive volumes of wastes that are dumped in various places that undergo from low water retention capacity (Ernst 1996), high electrical conductivity (Conesa et al. 2006), soil erosion (Tripathi et al. 2009 a,b), high pH values, low cation exchange capacity, pollution by heavy metals and low organic matter and nutrient concentration (Akla and Lal 2001, Asensio et al. 2011, Barrutia et al. 2011, Tripathi et.al.,2016a). This overburden is small to big mountain in the form of dumps this is called mine spoil (Singh et al., 1996a; Ekka and Behara 2011). These dumps change the natural land form and topography and affect the drainage system of mining area (Chaulya et al. 2000). Open cast mining often involves the removal of natively vegetated areas, and is therefore among the most environmentally – destructive types of mining, especially within the tropical forests (https://www.elaw.org). According to Tripathi et al., (2015) with disappearance of forest all attributes of the ecosystem is changed.

Hence natural succession of plant species on this area is delayed (Singh and Jha 1992, Singh et al. 1996b) and leads to acute environmental problems (Tripathi et al. 2016b) and health hazards to local dwellers (Singh and Tripathi, 2009) and wildlife. Mining is basically an obstructive development movement where ecology bears at the altar of economy (Chauhan 2010). Franklin et al (2012) reported that mine sites having rapid and dense herbaceous ground cover (HGC) growth stopped for light may be a main factor due to pitiable growth and endurance of some planted tree seedlings. Tripathi et al. (2009) opined the development of more herbaceous layer in subsided forest.

However impacts of mining industries on forests have not been well understood in the copper belt. The extraction of minerals from nature often creates natural imbalances, which adversely affect the environment. The primary disturbance caused in surface mining is the destruction of vegetation and top soil profile (Singh et al 1994, Tripathi et al., 2014). Vail and Whittwer (1982) stressed the importance of accumulation of biomass and nutrients in disturbed ecosystems. The key environmental impact of mining operation is to change the regeneration potential of herbaceous species and ultimately movement of wild animals to browse upon. Therefore management of a country's mineral resources must be closely associated with overall economic development, environmental protection & preservation strategies.

The main aim of this study was to depict the impact of copper mining on the herbaceous plant species and the occurrence of wild animals in the buffer zone of the HCM of India.

METHODS AND METHODOLOGY

Study area

HCM is the largest copper producers in India, it produces 70% of total copper production in India and is located in Balaghat district in central state of Madhya Pradesh. This study was carried out in Birsha –Damoh forest range circle spread over an area of 6809.04 ha and is bounded by latitude 21˚59'32.02"N longitude 80˚40' 37.48"E to latitude 21˚55'14.79"N longitude 80˚45' 06.38"E of Balaghat district of Madhya Pradesh (MP) State of India (Figure 1). It comes under the 10 km south of Hindustan copper mines. This forest range circle experiences a tropical monsoon type of climate with three distinct seasons i.e. winter (November – February), a hot summer (April- mid June) and rainy season (mid June - September). Mean minimum temperature ranged from 13.1°C to 33.4°C and mean maximum temperature from 19.5°C to 44.5°C. Annual average rainfall observed to be nearly 1054.8 mm, relative humidity varied between 40 to 86 % wind speeds in the area varied between 2 to 6 km/h. During summer the prominent wind direction were W, SW and NW, during winter E and SE and during rainy season NE, SE and SW. The soils in the study area are black cotton and alluvium. Birhsa- Damoh forest range Circles are selected for study in and around 10 KM of HCM due to more impact on herbaceous ground cover, during mid December 2011 to April 2012. Forest in the study area is generally southern tropical dry deciduous type (Champion & Seth 1968).

Sampling methods

Birsha –Damoh forest range circle distributed in 31 forest sites spread in buffer zone of Hindustan copper mines, MP, India. All sites were sampled through stratified random design by placing 1m x 1m quadrates in a long randomly placed transects that ran nominally across the forest site. Each quadrates was randomly placed within every 20-m interval of transect, with the exception of a non random quadrates that was placed at the forest end of transect. Quadrates were placed directly adjacent to the transect line. Within quadrates, the abundance of each plant species was estimated

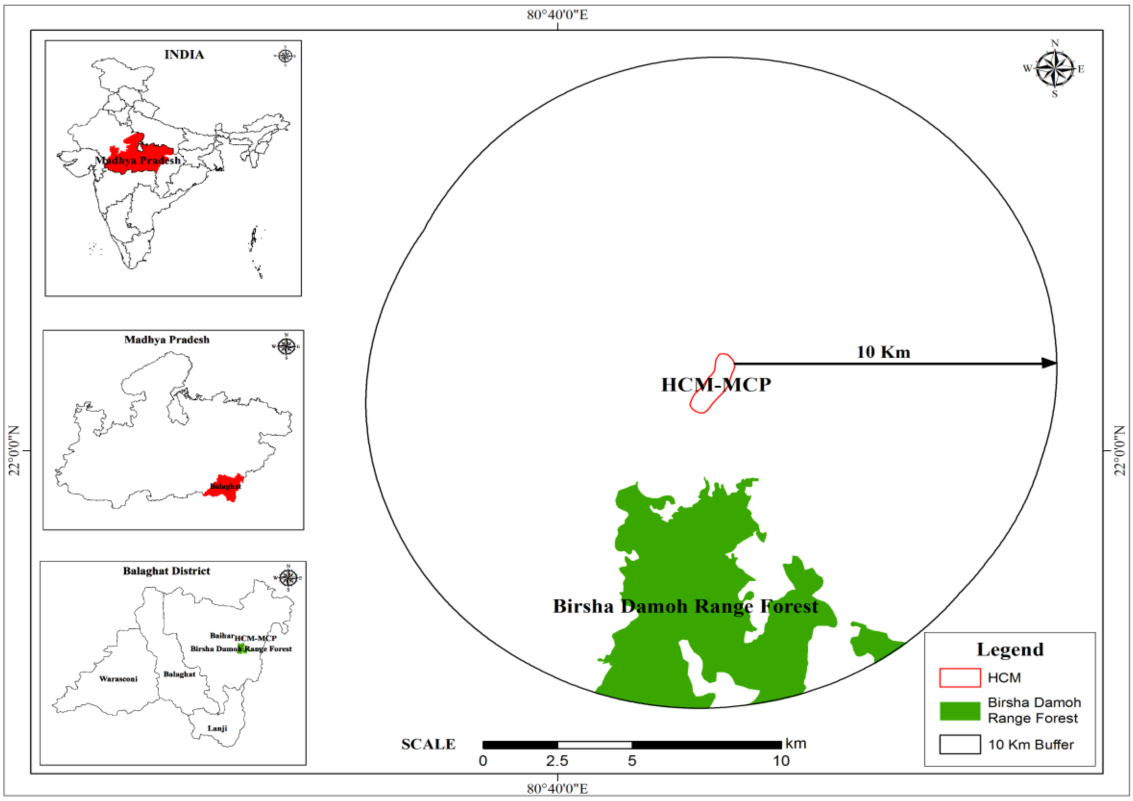

Figure 1. Location map of the study area

using a cover class method and a line intercept method (Mueller-Dombois and Ellenberg 1974). The plant species in each site were identified and recorded in field note book.

Data analysis

Herbaceous Ground Cover class data converted into percentage values (NSW 2006). The estimated ground cover was converted to ground cover assessment scale using zero to six cover scale adapted from the Daubenmire cover scale given in Table 1 (Mueller-Dombois and Ellenberg 1974).

$$\% \text{ Ground Cover} = \frac{\text{Total \%cover in species in all plot}}{\text{number of plot estimated}} \times 100$$

Table.1. Herbaceous ground cover assessment scale

Class	Range of Cover %
0	0
1	0-5
2	5-25
3	25-50
4	50-75
5	75-95
6	95-100

Source: - (Mueller-Dombois, & Ellenberg, 1974)

The faunal presence in the forest was estimated by direct and indirect methods. The direct methods involve counting subset of a region's population and then using this number with statistical estimator to arrive at an estimate the population size and the indirect method describe below involves the counting of occurrences of animal spoor (track, paw or hoof mark prints, droppings of animals) followed by statistical estimate of the population's size. (Krebs 1989).

RESULT AND DISCUSSION

The HGC in different sites is shown in Table 2. Among the herbaceous species *C. dactylon, L. camera and T. maxima* were dominant plant species across 19, 6 and 5 sites, respectively contributing 77.41% of total herbaceous ground cover. *Eulali trispicata* is dominant in only one site 1. The other constituent herbaceous plant species were *Vallaris heyne, Achyranthes aspera, Eragrostis tenella, Waltheria indica* and *Ocimum Gratissimum, Tribulus terrestris, Eulali trispicata, Triumfetta pilosa, Imperata cylindrica* contributed 22.59% of the HGC across all the sites. All the species are native and palatable by the herbivores except *L.camera*.

The average total HGC ranged between 11.2 - 77.44% with maximum value (77.44%) found at site 29 and the minimum value (11.2%) at site 14.

The HGC class recorded during study period was found to be in class 2, 3, 4 and 5 among 7, 16, 7 and 1 number of sites, respectively. The maximum HGC class 5 recorded at site 29 (Figure2).

Table 2. HGC status of forested study areas

Sl. No.	Avg ground cover. (%)	Cover class	Dominant Herbaceous Community
1.	42.1	3	*Eulali trispicata and Cynodon dactylon,*
2.	37.6	3	*Cynodon dactylon and Lantana camara,*
3.	37.2	3	*Cynodon dactylon and Lantana camara*
4.	25.4	3	*Thysanolaena maxima and Chrysopgon montanus,*
5.	28.5	3	*Cynodon dactylon* and *Lantana camara*
6.	33.2	3	*Cynodon dactylon* and *Imperata cylindrica,*
7.	39.24	3	*Cynodon dactylon* and *Lantana camara,*
8.	41	3	*Cynodon dactylon* and *Lantana camara*
9.	27.1	3	*Cynodon dactylon* and *Lantana camara*
10.	67.1	4	*Cynodon dactylon* and *Lantana camara,*
11.	24.2	2	*Cynodon dactylon* and *Eragrostis tenella,*
12.	59.2	4	*Cynodon dactylon* and *Lantana camara,*
13.	48.2	3	*Cynodon dactylon* and *Lantana camara,*
14.	11.2	2	*Lantana camara* and *Vallaris heynei,*
15.	45.3	3	*Lantana camara* and *Cynodon dactylon,*
16.	25.1	3	*Cynodon dactylon* and *Lantana camara*
17.	18.5	2	*Cynodon dactylon* and *Lantana camara*
18.	22.1	2	*Cynodon dactylon* and *Lantana camara*
19.	18.2	2	*Cynodon dactylon* and *Lantana camara*
20.	22.4	2	*Cynodon dactylon* and *Lantana camara*
21.	24.2	2	*Cynodon dactylon* and *Lantana camara*
22.	30.2	3	*Cynodon dactylon* and *Lantana camara*
23.	42.6	3	*Cynodon dactylon* and *Lantana camara*
24.	33.4	3	*Lantana camara* and *Cynodon dactylon*
25.	55.5	4	*Lantana camara* and *Cynodon dactylon,*
26.	45.2	3	*Thysanolaena maxima* and *Chrysopgon montanus,*
27.	65.3	4	*Thysanolaena maxima* and *Chrysopgon montanus,*
28.	65.4	4	*Thysanolaena maxima* and *Chrysopgon montanus,*
29.	77.44	5	*Lantana camara* and *Eragrostis tenella,*
30.	65.8	4	*Lantana camara* and *Cynodon dactylon,*
31.	73.1	4	*Thysanolaena maxima* and *Chrysopgon montanus,*
Minimum		11.20	
Maximum		77.44	
Average		36.79	

The maximum abundance of HGC with respect to frequency was in class 3 constituting 25-50% cover and minimum abundance class 5 constituting 75-95% cover (Figure 2).

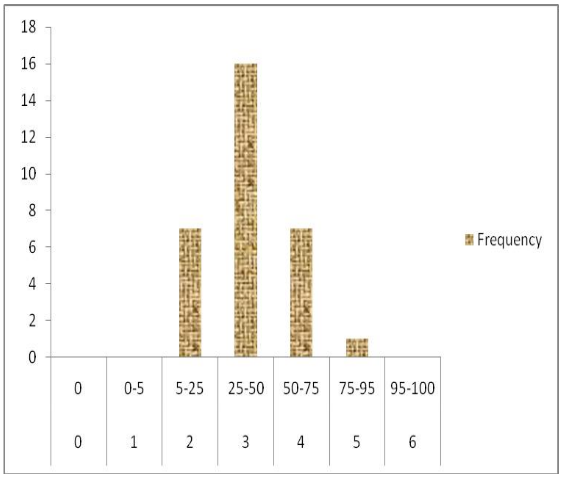

Figure 2. Frequency of ground cover (%)

The wild fauna study of the buffer zone forest areas revealed the presence of wild animals like *Axis axis, Bos gaurus, Canis aureus, Lepus nigricollis, Lutra prespicillata, Macaca mulatta, Melursus ursinus, Muntiacus muntjak, quadricornis muntjacus, Presbytis entellus, Panthera pardus, Sus scrofa* and *Vulpus bengalensis*. The maximum presence value (7) of wild fauna was observed at site 4 dominated by *Thysanolaena-Chrysopgon community* and minimum value (1) at site 29 dominated by *Lantana-Eragrostis community*. It indicated that wild fauna prefer the frequency of ground cover of 50-75% for their food and safety both.

It is interesting to note that the maximum presence of wild fauna was found in native palatable plant communities with nutritive foliage while the minimum presence was observed in *Lantana-Erogrostris* community. Our study indicated that *L. camera* is an exotic invader and a non palatable thorny plant species covering in most of the land areas cause hindrance to the herbivores wild animal movement. Consequently the presence of wild animals were found minimum at *L. camera* dominated sites.

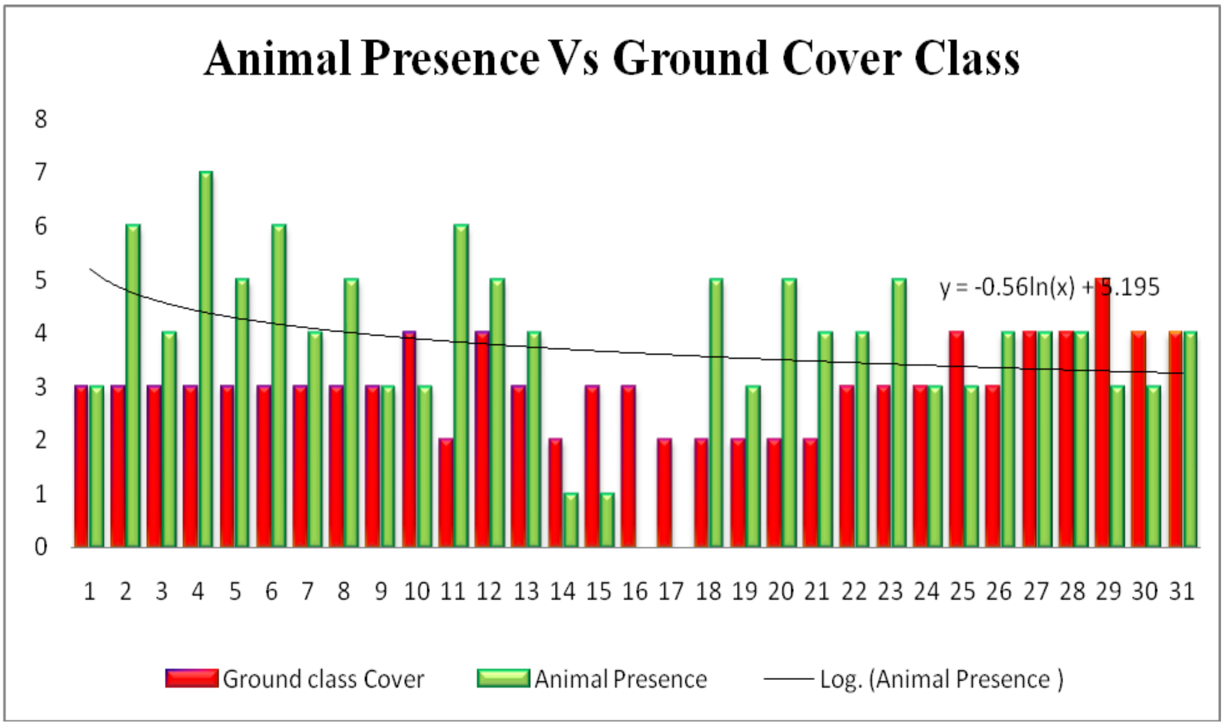

Figure 3. Cover class vs. Animal presence in Birha- Damoh Range forest, M.P.

Lantana camera an exotic plant species was found to be successfully invader and dominant at sites 14, 15, 24, 25, 29 and 30 and co-dominant in sites 2,3,5,7,8,9,10,12,13,16,17,18,19,20,21,22 and 23 in the buffer zone forest area of Birsa-Damoh forest range. According to Zinde (2016) *L. camara* invasion had lowered the diversity of native herbaceous species. If the preventive measures were not taken to eradicate the species there is maximum possibility to invade and encroach into adjacent all other forest sites. The possibility of its dominance in future may not be ruled out.

HGC of sites 16 and 17 was completely lacking due to anthropogenic activity of local villagers. Further it is the entrance site for the local domestic animal grazers and found near to the mining areas.

According to Tripathi and Singh, (2012) harvesting of forest for mining and local demand for fuel leads to the development of grassland and increasing grazing pressure might have reduced the herbaceous ground cover (Singh, et al., 1991a, b, Reese et al. 2001, West and Messmer 2006, Sanjari et al. 2006). The grazing pressure might have affected soil properties due to forest degradation (Singh et. al. 2007) by reducing plant cover as well as physical trampling by the domestic animal's hooves. Rizza et al. (2007) reported growing seasons stress contributed significantly to mortality by 27-60% of seedling death on a mine site in Tennessee. HGC maintains soil condition to sustain natural biotic communities. BLM (2006) reported the assumption that habitat management at the allotment (or pasture) level will actually affect animal presence and abundance. Further, herbaceous food is one of the important elements of sustainable diet to control the presence of wild fauna (FAO, 1995).

CONCLUSION

Finding of this study indicated that average HGC of the buffer forest area was 36.79%. While the optimum herbaceous ground cover with palatable native herbaceous species for wild animals were abundant at 50-75% for both herbivores and carnivores wild fauna. The maximum presence value (7) of wild fauna was observed at *Thysanolaena-Chrysopgon* community and minimum presence at *Lantana- Eragrostis community*. It indicated that wild fauna prefer the frequency of ground cover of 50-75% for their food and safety both. The herbaceous exotic plant species dominated by *Lantana* species has invaded in most of the site causing decrease in movement of the wild animals in most of sites for grazing and browsing. Consequently there is need of eradication and prevention of invading this plant species for better wild fauna management of Birsa- Damoh forest range area of MP state of India. It is pertinent to have long term monitoring of the forest to have precise abundance estimate of the wild fauna so as to develop strong conservation and management strategies in the buffer zone forest area of copper mines of HCL.

Acknowledgements

Authors grate fully acknowledge the financial support by the HCL, Kolkata and Director, CSIR-CIMFR for support and publishing the paper.

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Submitted: 13.01.2017
Accepted: 27.04.2017