HERBACEOUS DIVERSITY IN PROPOSED MINING AREA OF ROWGHAT IN NARAYANPUR DISTRICT OF CHHATTISGARH, INDIA

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Abstract: The study was conducted with the objective to analyze the structure and diversity of herbaceous vegetation in mining sites and to prepare eco-restoration plan for planting the key species in the adjacent degraded land surrounding environs of Rowghat area. The composition, structure and diversity of different forest sites/villages were conducted by stratified random sampling to measure herbaceous vegetation. The highest density of herbs was found in Bhusujkun Dongri followed by Khadkagaon. In this study we found that Godenmar Dongri and Bedhiyar Nala contained more number of species as compared to other study sites. The diversity pattern showed that the Parmad Dongri had maximum diversity followed by Bhusujkun Dongri and Ravdongri whereas Khodgaon had minimum Shannon index. In the Godenmar Dongri the density were much affected due to the present of various factors or by anthropogenic pressures which will ultimately results the gap in the regeneration status.

Keywords: Diversity, vegetation, herbaceous, deciduous forest

INTRODUCTION

Understory herbaceous vegetation is a vital component of deciduous forests, typically comprising the largest proportion of forest diversity (Tripathi et al. 1991, Bargali, 1994). Understory composition is often correlated with micro-environmental and site conditions such as topography, light availability and edaphic conditions and provides important indications of site quality, overstory regeneration patterns and ecosystem health (Joshi and Bargali, 1992a & b, Small, 2001). The global biodiversity crisis has given rise to a growing concern at the prospect of a rapidly accelerating loss of species, population, domesticated varieties, medicinal herbs and natural habitats. Recent estimates suggest that more than half of the habitable surface of the planet has already been significantly altered by the human activity (Hannah and Bowles, 1995) and we are on the verge of mass extinction of the species (Wilson, 1985).

Conservation biologists warn that 25% of all species could become extinct during the next 20 to 30 years. The cause for the loss of species is numerous but the most important is the loss and fragmentation of natural habitats. Biological diversity implies the variety of living organisms and includes diversity within species, between species and of ecosystems and the ecological processes of which they are a part (Gaston and Spicer, 2004). Species diversity is considered to be one of the key parameters characterizing ecosystems and a key component of ecosystem functioning (Larsson, 2001; Scherer-Lorenzen et al. 2005). Globally, biodiversity is changing at an unprecedented rate as a complex response to several human-induced changes (Vitousek, 1994; Hooper et al. 2005). These changes in biodiversity cause concern for ethical, economical, ecological and aesthetic reasons, but they also have a strong potential to alter ecosystem services such as the prevention of soil erosion and maintenance of hydrologic cycles and ecosystem goods, like tourism and recreation. Beyond the ecosystem services, biodiversity influences many ecosystems properties such as productivity, decomposition rates, nutrient cycling, resistance and resilience to perturbations (Loreau et al. 2001). Moreover, a high biodiversity is seen as an insurance against a decline in ecosystem services and should therefore be preserved (Yachi and Loreau, 1999). The structure of plant as well as animal communities in many natural ecosystems is largely influenced by the disturbances, frequently occurring in the system naturally or due to anthropogenic activities (Bennett and Adams, 2004; Eldered and Doak, 2006; Kwit and Platt, 2003). In many of these systems, disturbances change overall community structure (Shaforth et al. 2002) which in turn can ultimately affect community and population dynamics. In other words, the global environmental degradation has been severely occurred and has been introduced as one of the main environmental troubles worldwide. Studying vegetation and various environmental factors (e.g. physiographic, climate, soil etc.), the community stability and the factors correlation with the vegetation can be reached, which is crucial in terms of forest communities development and rehabilitation (Basiri, 2003). Grazing areas have become less productive resulting from over stocking of livestock. Conflicts over the use of land have increased due to increased demand for land by different sectors of the economy. Of particular concern are the conflicts among cultivators, livestock keepers, wildlife conservationists, individual land users and governments due to encroachment of humans into the protected areas (Hoare, 1999; Campbell et al. 2003). Forests are the primary source

to rejuvenate productivity of land through recycling of nutrients, which make physicochemical conditions of the soils favourable for plant growth (Bargali et al. 1998). The uncontrolled lopping and felling of trees for fuel wood, leaf fodder, burning of ground vegetation, livestock grazing and harvesting of ground vegetation for forage are some of the factors responsible for exploitation of forests (Bargali et al. 1998). Anthropogenic disturbances in forests followed by livestock grazing in pasture lands adversely affected the composition of herbaceous vegetation, it is therefore imperative to conserve the herbaceous vegetation of these sites.

Anthropogenic disturbances mining operations cause severe destruction in both physical and biological environment. The structure, diversity and functioning of vegetation will be affected due to change in edaphic, climatic, topographic and biotic conditions of the site. There may be huge losses in biological diversity of herbaceous and understory vegetation due to open cast mining. It becomes imperative to compensate the losses by planting the key species to maintain the eco restoration in adjacent degraded environment. Understanding the structure and diversity of herbaceous vegetation is necessary to identify the key species for their conservation and restoration of degraded environment. Specific objectives were to analyze the structure and diversity of herbaceous vegetation in mining sites and surrounding environs of Rowghat area and to prepare eco-restoration plan (environment management programme) for planting the key species in the adjacent degraded land.

MATERIAL AND METHOD

The study was carried out at Rowghat, Narayanpur district (Chhattisgarh) during the year 2010-2011. The study area is located between 19^0 00 to 19^0 41 North latitudes and 81^0 02 to 81^0 59 East longitudes. Geographically, Chhattisgarh is divided into three distinct land areas *viz.*, Chhattisgarh Plains, Bastar Plateau and Northern Hill Zones. The study site comes under Bastar Plateau and the Narayanpur district occupies an area of 6640 km² and it comprises 366 villages.

The vegetation was analysed for its structure in different sites. The herbaceous species were analysed by randomly laying ten quadrats of size 1 x 1 m in each site. Vegetational data were quantitatively analysed for frequency, density and abundance (Curtis and McIntosh 1950). The Simpson index (1949) was used for concentration of dominance and Margalef index (1958) for species richness. Diversity indices were calculated following Sagar and Singh (1999).

RESULT AND DISCUSSION

The density of herbs across the various forest sites ranged from 5,02,000 to 7,24,000 individuals ha^{-1} (Table 1). Maximum density of herb was recorded under Bhusujkun Dongri followed by Khadkagaon, Ravdongri and Takrel. Across all sites *Seteria sp* was recognized as dominant species. The maximum numbers of species (15) were recorded in Godenmar Dongri and Bedhiyar Nala followed by Parmad Dongri (14), Anjrel, Tarhur and Bhusujkun Dongri (12).

The Shannon index values recorded were ranged from 2.66 to 3.17. The values of Simpson's index were ranged from 0.14 and 0.23 for Ravdongri and Khodgaon. The species richness from 0.67 to 1.06 and the highest equitability value recorded by Ravdongri (1.33), whereas lowest was 1.09 for Godenmar. The beta diversity values were ranged from 2.40 to 3.60 (Table 2).

Diversity is considered to be an outcome of evaluation of species in a bio-geographic region. It is considered to be synthetic measure of the structure, complexity and stability of a community (Hubble and Foster, 1983). It is a combination of two factors; the number of species present, referred to as species richness and the distribution of individuals among species, referred to as species evenness or equability. Species diversity therefore, refers to the variation that exists among the different life forms. In the present study general structure of herbaceous species in all sites depicted an increasing trend in species number during the winter season. The reason for their maximum occurrence could be due to the availability of moisture present in the form of rains and other environmental factors. Alhassan *et al.* (2006) during their study period reported similar factors responsible for the variation in species number and diversity. According to Joshi and Bharti (2005) plants may facilitate other plants directly, by ameliorating harsh environmental conditions, altering substrate characteristics, or increasing the availability of a resource. During winter, with the decline in temperature, there was a marked accumulation of belowground biomass, perhaps due to translocation of food reserves to the belowground parts with the advent of unfavourable conditions for shoot growth.

The diversity parameters in the herb layer showed that the value of Shannon index in different sites varied from 2.66 to 3.17, equitability 1.09 to 1.33, species richness 0.67 to 1.06, concentration of dominance 0.14 to 0.23 and beta diversity 2.40 to 3.60 which is resemble with the findings made by Jhariya *et al.* (2012). Shameem *et al.* (2010) also reported the species diversity ranged from 1.80 to 3.03 which are found to be similar with present study. The minimum diversity in few sites may also be due to lower rate of evolution and diversification of communities (Simpson, 1964) and severity in environment (Connel and Oris, 1964). Concerning the species richness, a high number of species results with in higher community stability or rather resilience (Guo, 2001). This wide diversity takes the advantage of heterogeneity and increases their diversity. The level of heterogeneity created, obliviously would depend on the height and architecture of the woody species

Table 1: Vegetational analysis of herbaceous layer in different forest sites of Rowghat

	Anjrel			Khodgaon			Khadkagaon			Takrel			Ravdongari		
Species	**D**	**F**	**A/F**	**D**	**F**	**A/F**	**D**	**F**	**A/F**	**D**	**F**	**A/F**	**D**	**F**	**A/F**
Ageratum conyzaides	33000	60	0.09	23000	60	0.06	36000	70	0.07	--	--	--	44000	70	0.09
Cholorophytum tuberos	--	--	--	--	--	--	--	--	--	30000	70	0.06	--	--	--
Coriandrum setium	--	--	--	--	--	--	22000	80	0.03	--	--	--	--	--	--
Curcuma angestifolia	45000	60	0.13	66000	70	0.13	--	--	--	47000	60	0.13	69000	60	0.19
Cynthocline purpurea	--	--	--	--	--	--	--	--	--	23000	80	0.04	--	--	--
Cyprus procerus	--	--	--	--	--	--	31000	80	0.05	--	--	--	--	--	--
Desmodium heterophyllum	14000	50	0.06	--	--	--	--	--	--	--	--	--	127000	100	0.13
Digitaria ciliaris	--	--	--	34000	70	0.07	--	--	--	--	--	--	--	--	--
Echinochloa frumentaceae	--	--	--	--	--	--	--	--	--	20000	80	0.03	--	--	--
Echinocloa sp	16000	60	0.04	--	--	--	42000	80	0.07	--	--	--	--	--	--
Eragrostis japonica	--	--	--	--	--	--	--	--	--	25000	70	0.05	--	--	--
Eragrostis sp	--	--	--	--	--	--	41000	80	0.06	--	--	--	--	--	--
Eragrostis tenella	--	--	--	--	--	--	17000	70	0.03	--	--	--	--	--	--
Euphorbia heterophylla	--	--	--	--	--	--	--	--	--	232000	100	0.23	--	--	--
Euphorbia hirta	--	--	--	--	--	--	--	--	--	39000	70	0.08	--	--	--
Evolvulus nummalarius	43000	60	0.12	--	--	--	--	--	--	--	--	--	46000	60	0.13
Fimbristylis dichotoma	--	--	--	17000	50	0.07	--	--	--	--	--	--	46000	60	0.13
Floscopea scandens	48000	80	0.08	--	--	--	--	--	--	--	--	--	--	--	--
Heteropogon contortus	--	--	--	--	--	--	--	--	--	--	--	--	50000	60	0.14

Malvestrum coromandelica	--	--	--	--	--	--	--	--	--	--	--	--	18000	60	0.05
Microchloa indica	17000	50	0.07	--	--	--	171000	100	0.17	--	--	--	--	--	--
Mimosa pudica	13000	40	0.08	37000	80	0.06	--	--	--	--	--	--	--	--	--
Ocimum basilicum	--	--	--	61000	90	0.08	--	--	--	--	--	--	--	--	--
Peristnphe paniculate	--	--	--	--	--	--	29000	70	0.06	--	--	--	--	--	--
Perotis hordeiformis	27000	50	0.11	24000	60	0.07	--	--	--	--	--	--	--	--	--
Phyllanthus niruri	31000	80	0.05	19000	70	0.04	--	--	--	18000	70	0.04	--	--	--
Pteris sp	35000	60	0.10	19000	70	0.04	--	--	--	--	--	--	--	--	--
Setaria glauca	--	--	--	--	--	--	--	--	--	21000	60	0.06	--	--	--
Seteria homonyma	--	--	--	--	--	--	67000	80	0.10	--	--	--	--	--	--
Seteria sp	213000	100	0.21	234000	100	0.23	175000	80	0.27	149000	70	0.30	164000	70	0.33
Sida cordata	--	--	--	--	--	--	--	--	--	--	--	--	41000	60	0.11
Tridex procumbans	--	--	--	--	--	--	--	--	--	--	--	--	57000	80	0.09
Waltheria indica	--	--	--	--	--	--	--	--	--	56000	90	0.07	--	--	--
Zornia gibbosa	--	--	--	--	--	--	47000	80	0.07	--	--	--	--	--	--
	535000	**750**	**1.13**	**534000**	**720**	**0.85**	**678000**	**870**	**1.002**	**660000**	**820**	**1.09**	**662000**	**680**	**1.391**

Conti.

	Tarhur			**Godenmar Dongri**			**Parmad Dongri**			**Bhusujkun Dongri**			**Bedhiyar Nala**		
Species	**D**	**F**	**A/F**	**D**	**F**	**A/F**	**D**	**F**	**A/F**	**D**	**F**	**A/F**	**D**	**F**	**A/F**
Ageratum conyzaides	--	--	--	11000	70	0.02	40000	50	0.16	--	--	--	62000	60	0.17
Cassia tora	--	--	--	33000	60	0.09	--	--	--	--	--	--	--	--	--
Cholorophytum tuberos	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Coriandrum setium	--	--	--	--	--	--	15000	50	0.06	--	--	--	--	--	--
Curcuma angestifolia	49000	60	0.14	--	--	--	--	--	--	89000	60	0.24	56000	60	0.15
Cynthocline purpurea	--	--	--	--	--	--	--	--	--	42000	80	0.06	--	--	--
Cyprus procerus	--	--	--	--	--	--	14000	60	0.03	--	--	--	20000	60	0.05
Desmodium heterophyllum	--	--	--	--	--	--	--	--	--	65000	60	0.18	--	--	--
Digitaria ciliaris	9000	70	0.01	27000	60	0.07	--	--	--	--	--	--	9000	50	0.03
Echinochloa frumentaceae	--	--	--	--	--	--	23000	70	0.04	18000	60	0.05	23000	60	0.06
Echinocloa sp	--	--	--	--	--	--	28000	60	0.07	--	--	--	--	--	--
Eragrostis japonica	--	--	--	22000	70	0.04	--	--	--	31000	70	0.06	29000	60	0.08
Eragrostis sp	25000	80	0.03	--	--	--	--	--	--	--	--	--	--	--	--
Eragrostis tenella	--	--	--	--	--	--	20000	60	0.05	--	--	--	18000	50	0.07
Euphorbia heterophylla	--	--	--	--	--	--	--	--	--	121000	70	0.24	--	--	--
Euphorbia hirta	--	--	--	28000	60	0.07	--	--	--	--	--	--	--	--	--
Evolvulus nummalarius	36000	80	0.05	--	--	--	--	--	--	--	--	--	31000	70	0.06
Fimbristylis dichotoma	110000	70	0.22	--	--	--	--	--	--	--	--	--	--	--	--
Floscopea scandens	--	--	--	10000	70	0.02	--	--	--	--	--	--	11000	50	0.04
Heteropogon contortus	25000	60	0.06	--	--	--	--	--	--	--	--	--	--	--	--
Malvestrum coromandelica	--	--	--	--	--	--	28000	50	0.11	16000	60	0.04	--	--	--

Microchloa indica	--	--	--	9000	60	0.02	48000	60	0.13	--	--	--	--	--	--
Mimosa pudica	12000	50	0.04	12000	70	0.02	--	--	--	--	--	--	13000	60	0.03
Ocimum basilicum	--	--	--	9000	60	0.02	--	--	--	--	--	--	--	--	--
Peristnphe paniculate	--	--	--	23000	60	0.06	--	--	--	--	--	--	--	--	--
Perotis hordeiformis	--	--	--	--	--	--	30000	80	0.04	--	--	--	--	--	--
Phyllanthus niruri	--	--	--	11000	50	0.04	--	--	--	19000	70	0.03	29000	50	0.11
Pteris sp	--	--	--	--	--	--	25000	60	0.06	--	--	--	--	--	--
Rumex dentatus	14000	70	0.02	--	--	--	--	--	--	--	--	--	12000	50	0.04
Setaria glauca	43000	60	0.11	70000	70	0.14	--	--	--	54000	70	0.11	14000	50	0.05
Seteria homonyma	--	--	--	--	--	--	43000	70	0.08	--	--	--	--	--	--
Seteria sp	179000	80	0.27	215000	70	0.43	229000	70	0.46	220000	70	0.44	250000	70	0.51
Sida cordata	48000	80	0.07	12000	50	0.04	--	--	--	21000	70	0.04	21000	70	0.04
Tridex procumbans	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Waltheria indica	--	--	--	--	--	--	41000	60	0.11	28000	70	0.05	--	--	--
Zornia gibbosa	11000	80	0.01	10000	60	0.02	14000	60	0.03	--	--	--	--	--	--
	561000	**840**	**1.03**	**502000**	**940**	**1.1**	**598000**	**860**	**1.43**	**724000**	**810**	**1.54**	**598000**	**870**	**1.49**

***** D= Density (individuals ha^{-1}), F= Frequency, A/F= Abundance/Frequency

Table 2: Diversity pattern of herbaceous layer in different sites of Rowghat Forest

Forest Sites	Shannon Index (H')	Simpson's Index (Cd)	Species richness (d)	Equitability (e)	Beta Diversity (βd)
Anjrel	2.97	0.19	0.83	1.19	3.00
Khodgaon	2.66	0.23	0.68	1.15	3.60
Khadkagaon	3.01	0.16	0.74	1.25	3.27
Takrel	2.83	0.19	0.74	1.18	3.27
Ravdongri	3.06	0.14	0.67	1.33	3.60
Tarhur	2.99	0.17	0.83	1.2	3.00
Godenmar Dongri	2.97	0.22	1.06	1.09	2.40
Parmad Dongri	3.17	0.18	0.97	1.2	2.57
Bhusujkun Dongri	3.07	0.15	0.81	1.23	3.00
Bedhiyar Nala	3.05	0.2	1.05	1.12	2.40

Table 3: Major Species of Study Sites for conservation

Forest Sites	Major Species
Anjrel	*Seteria sp, Floscopea scandens, Curcuma angestifolia, Evolvulus nummalarius, Pteris sp*
Khodgaon	*Seteria sp, Curcuma angestifolia, Ocimum basilicum, Mimosa pudica, Digitaria ciliaris*
Khadkagaon	*Seteria sp, Microchloa indica, Seteria homonyma, Echinocloa sp, Eragrostis sp*
Takrel	*Euphorbia heterophylla, Seteria sp, Waltheria indica, Curcuma angestifolia, Euphorbia hirta*
Ravdongri	*Seteria sp, Desmodium heterophyllum, Curcuma angestifolia, Tridex procumbans, Heteropogon contortus*
Tarhur	*Seteria sp, Fimbristylis dichotoma, Curcuma angestifolia, Sida cordata, Setaria glauca*
Godenmar Dongri	*Seteria sp, Setaria glauca, Cassia tora, Euphorbia hirta, Peristnphe paniculate*
Parmad Dongri	*Seteria sp, Microchloa indica, Seteria homonyma, Waltheria indica, Perotis hordeiformis*
Bhusujkun Dongri	*Seteria sp, Euphorbia heterophylla, Curcuma angestifolia, Desmodium heterophyllum, Setaria glauca*
Bedhiyar Nala	*Seteria sp, Curcuma angestifolia, Evolvulus nummalarius, Phyllanthus niruri, Eragrostis japonica*

(Sagar *et al*. 2008). The disturbed areas or site supports more herbaceous vegetation as compared to undisturbed area because of reduction in competition for space and resources. Moretti *et al.* (2002) and Keith *et al.* (2010) have reported the similar results and stated that the herb species increase in number immediately due to the anthropogenic disturbance because of a general reduction in the tree cover that brings more light to the soil and for growing understory.

AF ratio was used to assess the distribution pattern of the species. In the present estimates most of the species showed contagious and random distribution pattern whereas regular distribution was found almost negligible across the study sites. Shadangi and Nath (2005) also reported maximum species in contagious distribution pattern in the area. In natural condition contagious distribution is most common type of distribution pattern described by Odum (1971). The pattern of distribution of species depends both on the physico-chemical nature of the environment as well as on the biological peculiarities of the organisms themselves.

Suggestions for restoration/ conservation of major herbaceous vegetation

- Since soil is considered as a large seed bank, so soil of the top most layers could be scratched and spread over the new site and after the commencement of favourable climatic conditions the seeds/ rhizomes/ tubers will germinate it and flourish.
- Seed/rhizomes/tubers can be collected from the main site of the mining areas where the abundant plants are available than these plant materials can be grown/shifted on the proposed new recovery sites.

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