Asian Journal of

Earth Sciences

ISSN 1819-1886

Academic Journals Inc.

www.academicjournals.com

Asian Journal of Earth Sciences 7 (2): 51-59, 2014
ISSN 1819-1886 / DOI: 10.3923/ajes.2014.51.59

Floristic Diversity Assessment in River Sand Mining near Palri Bhoptan Village, Kisangarh Tehsil, Ajmer District, Rajasthan, India

[1]Niteesh Kumar and [2]Ajay Kumar
[1]Deparment of Plant Physiology, Division of Botany, Forest Research Institute, Dehradun, India
[2]Rain Forest Research Institute, Jorhat, Assam, India

Corresponding Author: Niteesh Kumar, Deparment of Plant Physiology Division of Botany, Forest Research Institute, Dehradun, India

ABSTRACT

A phytosociological study of river sand mine near Palri Bhoptan village, tehsil-Kisangarh, district Ajmer, Rajasthan has been undertaken to evaluate the impact of restorative interventions on floristic structure and composition. The study was aimed at enumeration of the available plant resources and obtaining a broad representation of the existing floristic variations in the mine lease area and surrounding mine buffer areas. The mine lease area is located near villages Bhanwata, Narwar, Manpura, Beer, Oontra, tehsil-Ajmer, district-Ajmer, Rajasthan. One protected forest lies within the project affected village i.e., in Palri Bhoptan while one protected forest and one open scrub lies in buffer zone of the project area. Mining is a major source of economy in Rajasthan but is also a major cause of ecological disturbance due to the land degradation and related changes in the structural and functional characteristics of the native vegetation. This study describes the floristic composition and phytodiversity assessment of mining and mining surrounding area.

Key words: Phytosociological study, ecologically restored, degraded land, floristic composition, phytodiversity assessment

INTRODUCTION

Mining and mineral processing adversely affects the ecology of the area by disturbing the land mass, the water systems and floral faunal population and in turn, the quality of human life. Rajasthan is India's largest state by area (342,239 km^2 (132,139 mi^2) or 10.4% of India's total area). Several prominent chemical and engineering companies are located in the city of Kota in southern Rajasthan. Rajasthan is pre-eminent in quarrying and mining in India. Availability and optimal utilization of its resources, mainly natural resources, make the foundation of economic development of a region. The state of Rajasthan has varied ecosystems (Chouhan, 1996) and is also rich in mineral resources. Open cast mining is a major cause of ecological disturbances due to the land degradation and related changes in the structural and functional characteristics of the native vegetation. Mining causes the destruction of natural ecosystems through removal of top soil and vegetation and their burial beneath the waste disposal sites. Anthropogenic disturbances caused due to mining produces shifts in the structure/richness of the vegetation of the hitherto native species which dominated ecosystem. Disturbance to an ecosystem means, any discrete event that disrupts the ecosystem, community or population structure or the physical environment (Pickett and White, 1985). In India, major disturbances to forest ecosystems include habitat destruction, over exploitation, environmental pollution and other anthropogenic pressure. Understanding of the effects of the disturbances on ecosystem function and plant biodiversity of the site may play useful role in the restoration attempts through re-vegetation of native plant species.

On the vegetation aspect, Majumdar (1976) has carried out an appreciable work under the title "Synoptic Flora of Kota Division" in which he has reported 700 species occurring in this region. Other researchers who have studied the vegetation of Kota division are Maheshwari and Singh (1976) etc. Ecology and vegetation of Kota and Shahabad have been studied plants and/or persistence of native species by Jain and Kotwal (1960) and Gupta (1965). Forests constitute an important component of the physical environment of the state. The total forest cover of the state is 15,850 km^2 which constitute 4.63% of the geographic area. The recorded forest area of the state is 32,639 km^2 which is 9.54% of the state's geographical area (FSI, 2011). District Kota covers 11.30% forest cover of its geographical area (FSI, 2011).

The dry tropical forests accounts for 38.2% of the total forest cover of India (MoEF, 1999) and are under constant disturbances of both the climatic and anthropogenic origin. Disturbances, mainly anthropogenic, lead to the conversion of species-rich forests into species-poor forest ecosystems. Habitat destruction is the leading cause of species extinction and biodiversity loss in natural ecosystems (Koh *et al.*, 2004; Pimm and Raven, 2000). Unfortunately, studies on tropical dry deciduous forests in relation to the disturbances are much limited in India (Khera *et al.*, 2001; Puyravaud *et al.*, 1995) particularly in context of mining in the present study area. Exhaustive knowledge of the species and ecosystem diversity and distribution is pre-requisite for identification of conservation areas (Angelstam *et al.*, 2004; Felix *et al.*, 2004). Hence, the present study focuses on the assessment of the plant diversity in and around the areas with extensive mining operations where huge quantities of mining wastes are present changing the topography and related hydrological regime of the study area.

STUDY AREA

Palri Bhoptan is a small village/hamlet in Kishangarh tehsil in Ajmer district of Rajasthan state, India. It comes under Palri Bhoptan Panchayath. It belongs to Ajmer Division. It is located 29 km towards East from district head quarters Ajmer, 118 km from state capital Jaipur. Palri Bhoptan is surrounded by Srinagar tehsil towards South, Arain tehsil towards East, Ajmer tehsil towards West and Parbatsar tehsil towards North.

The mine lease area is located near villages Bakarwaliya, Sinodiya, Bhadun, Palri Bhopatan, tehsil-Kishangarh, district-Ajmer, Rajasthan. The lease area lies on river Rupangarh. The latitudes and longitudes of mine lease area is 26°51'11.03 "N-26°55'56.22" N and 74°47'22.14 "E-74°58'0.65" E, respectively.

METHODOLOGY

Phyto-sociological analysis: The study was aimed at enumeration of the available plant resources and obtaining a broad representation of the existing floristic variations in the mine lease area and surrounding mine buffer areas. Enumeration of the plant wealth was done by surveying the area through walking followed by identification of plant specimens. Phyto-sociological aspects of the study were carried out by perambulating and sampling through quadrates method. Sample plots were selected in such a way to get maximum representation of different types of vegetation and plots were laid out in different parts of the areas within the mine area as well as the surrounding mine area (buffer zone). Selection of sites for vegetation data was done by random sampling procedure.

Ecological study of the vegetation includes the investigation of species composition and the sociological interactions of the species in communities (Mueller-Dombois and Ellenberg, 1974). It lays emphasis on study of species association, development, geographic distribution and environmental relationships of plant communities. Their interactions among different plants and between plants and their environment result in the outcome of different vegetation types in different areas. The quantitative relationship between rare and profusely growing species is an important structural property of a community.

Nested quadrates techniques were used for the sampling of the vegetation. The size and number of quadrates needed were determined using the species area curve (Mishra, 1968) and the running mean method (Kershaw, 1973). Summarization of previously used methods and recommendations led to the use of more than ten, 10×10 m quadrates have been laid out for sampling the tree stratum and 1×1 m quadrates for herbs, grasses and seedlings of tree species. The shrub species and saplings were sampled by using 3×3 m sample plots or quadrates. The enumeration of the vegetation in each of the quadrate was done by measuring DBH individually in case of woody vegetation and collar diameter in case of herbs and grasses with the help of tree caliper and electronic digital caliper. In case of grasses and sedges, each erect shoot is considered as a plant tiller and the enumeration was done by lying 1×1 m quadrates at random, further subdivided into 10×10 cm segments. Four such segments selected at random were analyzed from each quadrate by counting the tillers individually as per the method used was that of Singh and Yadava (1974).

The vegetation data was quantitatively analyzed for density, frequency and abundance following the methods of Curtis and McIntosh (1950). The relative values of frequency, density and dominance were determined as per Philips (1959). These values were summed up to represent IVI (Importance Value Index) of individual species (Curtis, 1959).

Equations used for various calculations are:

$$\text{Density} = \frac{\text{Total No. of individuals of a species in all the quadrats}}{\text{Total No. of quadrats studied}}$$

$$\text{Frequency (\%)} = \frac{\text{Total No. of quadrats in which species occurred}}{\text{Total No. of quadrats studied}} \times 100$$

$$\text{Abundance} = \frac{\text{Total No. of individuals of a species in all quadrats}}{\text{Total No. of quadrats in which species occurred}}$$

$$\text{Mean basal area} = \frac{C^2}{4\pi}$$

where, “C” is mean of the circumference

$$\text{Total basal area} = \text{Mean basal area} \times \text{Density}$$

$$\text{Mean of the circumference(C)} = \frac{\text{Sum of all CBH of a specie}}{\text{Total No. of individuals of a specie}}$$

$$\text{Relative density} = \frac{\text{Density of a species}}{\text{Total density of all species}} \times 100$$

$$\text{Relative frequency} = \frac{\text{Frequency of a species}}{\text{Total frequency of all species}} \times 100$$

$$\text{Relative dominance} = \frac{\text{Total basal cover of a species}}{\text{Total basal cover of all species}} \times 100$$

Importance Value Index (IVI) =Relative density+Relative frequency+Relative dominance

RESULT

Mine lease area: A general view of mine lease area near Palri Bhoptan is shown in Fig. 1. Vegetation parameters of woody species, shrubs and herbs encountered in the sample plots are shown in Table 1. The density of tree species varied from 14.29-71.43 stems ha^{-1}. Highest density was shown by *Acacia catechu* (71.43 stems ha^{-1}) followed by *Azadirachta indica* (57.14 stems ha^{-1}). The stand basal area of tree species was 171.43 stem ha^{-1} (Table 1).

Table 1: Vegetation parameters of trees in project affected area (mine lease area)

Species	Occ.	No.	TBA	Density ha^{-1}	Freq.	RDo	RD	RF	IVI
Acacia catechu	3	5	7202.1	71.43	0.43	21.33	41.67	42.86	105.85
Azadirachta indica	2	4	4684.9	57.14	0.29	13.87	33.33	28.57	75.78
Ficus benghalensis	1	1	21124.1	14.29	0.14	62.55	8.33	14.29	85.17
Prosopis juliflora	1	2	760.265	28.57	0.14	2.25	16.67	14.29	33.20
Total	7	12	33771.3	171.43	1.00	100.00	100.00	100.00	300.00

Fig. 1: General view of mine lease area near Palri Bhoptan

Table 2: Vegetation parameters of shrubs in project affected area (mine lease area)

Species	Occ.	No.	TBA	Density ha^{-1}	Freq.	RDo	RD	RF	IVI
Acacia nilotica	3	5	524.986	793.57	0.43	14.37	8.06	20.00	42.44
Calotropis procera	5	18	538.855	2856.86	0.71	14.75	29.03	33.33	77.12
Prosopis juliflora	6	36	2352.77	5713.71	0.86	64.40	58.06	40.00	162.47
Ricinus communis	1	3	236.563	476.14	0.14	6.48	4.84	6.67	17.98
Total	15	62	3653.18	9840.29	2.14	100.00	100.00	100.00	300.00

Table 3: Vegetation parameters of herbs in project affected area (mine lease area)

Species	Occ.	No.	TBA	Density ha^{-1}	Freq.	RDo	RD	RF	IVI
Achyranthus aspera	3	9	32.27	12857.14	0.43	1.41	4.23	4.00	9.63
Boerhavia diffusa	6	18	163.11	25714.29	0.86	7.11	8.45	8.00	23.56
Commelina benghalensis	1	6	95.57	8571.43	0.14	4.17	2.82	1.33	8.32
Cynodon dactylon	7	35	143.21	50000.00	1.00	6.24	16.43	9.33	32.01
Cyperus rotundus	7	14	62.55	20000.00	1.00	2.73	6.57	9.33	18.63
Eleusine indica	7	14	43.54	20000.00	1.00	1.90	6.57	9.33	17.80
Emilia sonchifolia	1	2	32.73	2857.14	0.14	1.43	0.94	1.33	3.70
Euphorbia hirta	5	15	134.33	21428.57	0.71	5.85	7.04	6.67	19.56
Paspalum disticum	7	14	51.30	20000.00	1.00	2.24	6.57	9.33	18.14
Paspalum scrobiculatum	5	10	124.41	14285.71	0.71	5.42	4.69	6.67	16.78
Phyllanthus niruri	4	4	3.73	5714.29	0.57	0.16	1.88	5.33	7.37
Saccharum munja	3	18	273.94	25714.29	0.43	11.94	8.45	4.00	24.39
Setaria glauca	2	4	22.40	5714.29	0.29	0.98	1.88	2.67	5.52
Solanum vivarum	6	6	428.88	8571.43	0.86	18.69	2.82	8.00	29.51
Tribulus terrestris	3	6	33.59	8571.43	0.43	1.46	2.82	4.00	8.28
Tridex procumbens	5	35	557.48	50000.00	0.71	24.30	16.43	6.67	47.40
Xanthium indicum	3	3	91.16	4285.71	0.43	3.97	1.41	4.00	9.38
Total	75	213	2294.20	304285.71	10.71	100.00	100.00	100.00	300.00

The number of shrubs and tree saplings together from mine lease area was 4 species. The mine lease area was dominated by *Prosopis juliflora* and *Calotropis procera*. The forest with open canopy cover and dry soil conditions do not favoured the growth of woody climbers and shrubs. The density values (stems ha^{-1}) for different species of shrubs varied from 476.14-5713.71 (Table 2). *Prosopis juliflora* recorded the highest IVI value (162.47). This particular shrub has very good capacity for regeneration.

Herbaceous vegetation accounted for 17 species in the mine lease area. The stand density in the case of herbaceous species was 304285.71 stems ha^{-1} (Table 3) and this strata was dominated by *Cynodon dactylon* and *Tridex procumbens* (50000 stems ha^{-1}) and *Saccharum munja* and *Boerhavia diffusa* (25714.29 stems ha^{-1}) (Table 3).

Dominance and ecological success of a species is expressed as a single value in terms of Importance Value Index (IVI). This index utilizes three parameters viz., relative frequency, relative density and relative dominance or basal area. High IVI values of a species indicate its high regeneration capacity and greater ecological amplitude. Among trees species, *Acacia catechu* showed highest IVI (105.85) followed by *Ficus benghalensis* (85.17) and *Azadirachta indica* (75.78). *Acacia catechu* alone is significant in occupying majority of space and resources being represented by 1/3rd (105.85) of the total IVI in the mine lease area (Table 1). Among shrubs, highest IVI was recorded as 162.47 and 77.12 in the case of *Prosopis juliflora* and *Calotropis procera*, respectively

Table 4: Vegetation parameters of trees in surrounding mine lease area

Species	Occ.	No.	TBA	Density ha^{-1}	Freq.	RDo	RD	RF	IVI
Acacia catechu	2	3	1106.62	50.00	0.33	8.82	14.29	20.00	43.10
Acacia nilotica	2	3	1554.30	50.00	0.33	12.38	14.29	20.00	46.67
Azadirachta indica	3	9	5991.08	150.00	0.50	47.74	42.86	30.00	120.59
Eucalyptus citriodora	1	3	1717.66	50.00	0.17	13.69	14.29	10.00	37.97
Ficus religiosa	1	1	1385.44	16.67	0.17	11.04	4.76	10.00	25.80
Prosopis juliflora	1	2	795.216	33.33	0.17	6.34	9.52	10.00	25.86
Total	10	21	12550.34	350.00	1.67	100.00	100.00	100.00	300.00

Table 5: Vegetation parameters of shrubs in surrounding mine lease area

Species	Occ.	No.	TBA	Density ha^{-1}	Freq.	RDo	RD	RF	IVI
Azadirachta indica	2	3	678.40	50.00	0.33	13.59	5.17	12.50	31.26
Caesalpinia pulcherrima	1	1	254.47	16.67	0.17	5.10	1.72	6.25	13.07
Calotropis procera	4	10	197.47	166.67	0.67	3.96	17.24	25.00	46.20
Prosopis juliflora	5	36	2061.02	600.00	0.83	41.28	62.07	31.25	134.60
Ricinus communis	2	6	1439.81	100.00	0.33	28.84	10.34	12.50	51.68
Toona ciliata	1	1	204.09	16.67	0.17	4.09	1.72	6.25	12.06
Ziziphus mauritiana	1	1	157.48	16.67	0.17	3.15	1.72	6.25	11.13
Total	16	58	4992.74	966.67	2.67	100.00	100.00	100.00	300.00

(Table 2). Highly regenerating species in the study site among shrubs was *Prosopis juliflora*. Among herbaceous species, *Tridex procumbens* (47.40) followed by *Cynodon dactylon* (32.01) showed highest IVI in the mine lease area (Table 3).

Surrounding mine lease area (Buffer Zone): Vegetation parameters of woody species, shrubs and herbs encountered in the sample plots are shown in Table 4. The density of tree species varied from 16.67-150 stems ha^{-1}. Highest density was shown by *Azadirachta indica* (150 stems ha^{-1}) followed by *Acacia catechu, Acacia nilotica* and *Eucalyptus citriodora* (each 50 stems ha^{-1} respectively). The stand basal area of tree species was 350 stem ha^{-1} (Table 4).

The number of shrubs and tree saplings together from surrounding mine lease area was 7 species. The surrounding mine lease area was dominated by *Prosopis juliflora* and *Calotropis procera*. The forest with open canopy cover and dry soil conditions do not favoured the growth of woody climbers and shrubs. The density values (stems ha^{-1}) for different species of shrubs varied from 16.67-600 (Table 5). *Prosopis juliflora* recorded the highest IVI value (134.60). This particular shrub has very good capacity for regeneration.

Herbaceous vegetation accounted for 21 species in the surrounding mine lease area. The stand density in the case of herbaceous species was 2733.33 stems ha^{-1} (Table 6) and this strata was dominated by *Saccharum munja* (300 stems ha^{-1}) followed by *Euphorbia hirta* and *Boerhavia diffusa* (250.00 stems ha^{-1}) (Table 6).

Dominance and ecological success of a species is expressed as a single value in terms of Importance Value Index (IVI). This index utilizes three parameters viz., relative frequency, relative density and relative dominance or basal area. High IVI values of a species indicate its high regeneration capacity and greater ecological amplitude. Among trees species, *Azadirachta indica* showed highest IVI (120.59) followed by *Acacia nilotica* (46.67) and *Acacia catechu* (43.10). *Azadirachta indica* alone is significant in occupying majority of space and resources being represented by 1/3rd (120.59) of the total IVI in the surrounding mine lease area (Table 4). Among

Table 6: Vegetation parameters of herbs in surrounding mine lease area

Species	Occ.	No.	TBA	Density ha^{-1}	Freq.	RDo	RD	RF	IVI
Achyranthus aspera	6	14	471.21	233.33	1.00	14.45	8.54	9.52	32.52
Argemone mexicana	1	2	177.16	33.33	0.17	5.43	1.22	1.59	8.24
Boerhavia diffusa	5	15	135.92	250.00	0.83	4.17	9.15	7.94	21.25
Calotropis procera	1	2	174.83	33.33	0.17	5.36	1.22	1.59	8.17
Commelina benghalensis	1	6	95.57	100.00	0.17	2.93	3.66	1.59	8.18
Cynodon dactylon	3	13	92.67	216.67	0.50	2.84	7.93	4.76	15.53
Cyperus rotundus	5	10	44.68	166.67	0.83	1.37	6.10	7.94	15.40
Datura metel	2	4	376.00	66.67	0.33	11.53	2.44	3.17	17.15
Eleusine indica	5	10	31.10	166.67	0.83	0.95	6.10	7.94	14.99
Emilia sonchifolia	1	2	32.73	33.33	0.17	1.00	1.22	1.59	3.81
Euphorbia hirta	5	15	134.33	250.00	0.83	4.12	9.15	7.94	21.20
Paspalum disticum	5	10	36.64	166.67	0.83	1.12	6.10	7.94	15.16
Paspalum scrobiculatum	3	6	74.65	100.00	0.50	2.29	3.66	4.76	10.71
Rungia pectinata	1	1	60.27	16.67	0.17	1.85	0.61	1.59	4.05
Saccharum munja	3	18	273.94	300.00	0.50	8.40	10.98	4.76	24.14
Setaria glauca	3	6	33.59	100.00	0.50	1.03	3.66	4.76	9.45
Sida rhombifolia	3	6	209.65	100.00	0.50	6.43	3.66	4.76	14.85
Solanum viarum	6	6	474.68	100.00	1.00	14.56	3.66	9.52	27.74
Tridex procumbens	2	14	222.99	233.33	0.33	6.84	8.54	3.17	18.55
Xanthium indicum	1	2	96.06	33.33	0.17	2.95	1.22	1.59	5.75
Setaria glauca	1	2	11.20	33.33	0.17	0.34	1.22	1.59	3.15
Total	63	164	3259.88	2733.33	10.50	100.00	100.00	100.00	300.00

shrubs, highest IVI was recorded as 134.60 and 51.68 in the case of *Prosopis juliflora* and *Ricinus communis*, respectively (Table 5). Highly regenerating species in the study site among shrubs was *Prosopis juliflora*. Among herbaceous species *Achyranthus aspera* (32.52) followed by *Solanum viarum* (27.74) showed highest IVI in the surrounding mine lease area (Table 6).

Floristic composition varies depending upon the site and its environmental features and it is one of the major characteristic features of any plant communities. The flora of the mine lease area dominated by prosopis vegetation consisted of 24 species belonging to 22 genera and 14 families. The flora of the surrounding mine lease area dominated by prosopis vegetation consisted of 30 species belonging to 28 genera and 18 families. The study showed that regeneration of most of the woody species recorded in mine lease was very poor.

DISCUSSION AND CONCLUSION

The phytosociological study is imperative to understand the structure and function of a particular vegetation community. The structure and distribution of trees, shrubs and other ground flora are very sensitive to change within a short span of time and the major factors influencing these changes are bio-edaphic including two factors that influenced growth performance of species in forestland which are edaphic factors (soil texture, moisture content, bulk density, particle density, organic matter and nutrient content) and climatic factors (Hassan *et al.*, 2007). These factors exert strong influences on plant development which, in turn, improve the micro-habitat by regulating the community structure and ecosystem functioning (Soni *et al.*, 1994).

Importance Value Index (IVI) is a device to rank species in a community and often used to elucidate features of the community (Lamont *et al.*, 1977). Natural invasion of trees into revegetated sites can be affected by the types of plant species already growing in the site as well as by resource availability. The establishment of tree plantations in degraded areas may facilitate regeneration of native species that could not establish in open micro-sites or in competition by herbaceous species (Rajdeep *et al*., 2011; Kumar *et al*., 2014). This increase in biodiversity is of great importance due to the functional role, especially of soil fauna, for soil properties and self regulation potential of intensive forest ecosystems. Gibson *et al*. (1985) reported that natural re-vegetation by trees was a complex process controlled primarily by dispersal mechanisms of the tree species.

Primary impacts of mineral exploration are the removal of vegetation and disturbance of the ground in the immediate vicinity of the principal activities. Excavation of the substrate materials and dumping of the mine-spoils also alter the soil profile, hydrology, topography and nutrient status of the substrate. These secondary factors have the potential to result in deleterious effects on the local biodiversity. The change in vegetation affects the rates of carbon and nitrogen cycling, ecosystem productivity, microbial community and structure and soil functional processes, thus, causing the change in whole status of the biodiversity. At the landscape level, environmental impacts occur generally in the form of alteration of the land-form features and fragmentation of the biological habitats that may cause isolation of populations of floral and faunal species. Generally, plant species with high tolerance of such disturbances are at a competitive advantage during initial colonization and subsequent establishment. There is, therefore, a great need to protect or conserve remnants of primary forests and late succession species in such tracts of vegetation. Natural succession on the degraded lands due to mining is the most suitable process of restoration. Thus, to accelerate the process of natural succession, species used in restoration projects should be chosen from the local vegetation. The success of bio-restoration of the degraded landscapes for environmental protection may be built on the recruitment of native components of biodiversity for re-vegetation.

In terms of the restoration planning, the analysis of natural regeneration processes represents a valuable starting point for the selection of suitable species to be used. There is need to conserve the floristic diversity of the remnant patches of the vegetation stands because these vegetation-stands play important role in colonization after the disturbance. There is tremendous scope to develop the disturbed sites, in and around mining areas, as range lands through Silvi Pastoral land use approach in an attempt to restore the native vegetation. Selected plant species can be introduced inappropriately prepared mine spoils or degraded soils in suitable climatic conditions to get established easily in such areas. Silvi-pastoral approach is the best means of restoration because it may involve human systems approach, as well, by fulfilling the requirement of fuel and fodder of local inhabitants.

REFERENCES

Angelstam, P., M. Donz-Breuss and J.M. Roberge, 2004. Targets and tools for the maintenance of forest bio-diversity: An introduction. Ecol. Bull., 51: 11-24.

Chouhan, T.S., 1996. Natural and Human Resources of Rajasthan. Scientific Publishers, Jodhpur, India, Pages: 592.

Curtis, J.T. and R.P. McIntosh, 1950. The interrelations of certain analytic and synthetic phytosociological characters. Ecology, 31: 434-455.

Curtis, J.T., 1959. The Vegetation of Wisconsin: An Ordination of Plant Communities. University of Wisconsin Press, Madison, WI., USA., Pages: 657.

FSI, 2011. India state of forest report 2011. Forest Survey of India, Ministry of Environment and Forests, Dehradun, India, pp: 208-213.

Felix, A.B., H. Campa III, K.F. Millenbah, S.R. Winterstein and W.E. Moritz, 2004. Development of landscape-scale habitat-potential models for forest wildlife planning and management. Wild life Soc. Bull., 32: 795-806.

Gibson, D.J., F.L. Johnson and P.G. Risser, 1985. Revegetation of unclaimed coal strip mines in Oklahoma-11. Plant communities. Reclamation Revegetation Res., 4: 31-47.

Gupta, R.S., 1965. Vegetation of Kota and its neighbourhood. Trop. Ecol., 63: 63-71.

Hassan, A., R. Wahab, M.A. Alias and RM. Salim, 2007. Growth performance of 9-years-old selected 5 indigenous wood species planted on degraded forest land. Int. J. Agric. Res., 2: 302-306.

Jain, S.K. and N.N. Kotwal, 1960. On the vegetation of Shahabad in Rajasthan. J. Indian For., 86: 602-608.

Kershaw, K.K., 1973. Quantitative and Dynamic Plant Ecology. 2nd Edn., FLBS and Edwards Arnold Publication, London, UK., Pages: 308.

Khera, N., A. Kumar, J. Ram and A. Tewari, 2001. Plant biodiversity assessment in relation to disturbances in mid-elevational forest of Central Himalaya, India. Trop. Ecol., 42: 83-95.

Koh, L.P., R.R. Dunn, N.S. Sodhi, R.K. Colwell, K.C. Proctor and V.S. Smith, 2004. Species coextinctions and the biodiversity crisis. Science, 305: 1632-1634.

Kumar, N., A. Kumar and M. Singh, 2014. Floristic diversity assessment in ecologically restored limestone (building stone) mine near Chechat village, Kota district, Rajasthan. Ecologia, 4: 16-25.

Lamont, B.B., S. Downes and J.E.D. Fox, 1977. Importance value curves and diversity indices applied to species rich health land in Western Australia. Nature, 265: 438-441.

Maheshwari, J.K. and V. Singh, 1976. Supplement to the synoptic Flora of kota division Southeastern Rajasthan India. Bull. Bot. Surv. India, 18: 155-160.

Majumdar, R.B., 1976. Synoptic flora of Kota division (South East Rajasthan) II. Bull. Bot. Surv. India, 13: 105-146.

Mishra, R., 1968. Ecology Workbook. Oxford and IBH Publishing Inc., Calcutta, India, Pages: 242.

MoEF, 1999. National policy and macrolevel action strategy on biodiversity. Ministry of Environment and Forest, Government of India, New Delhi, India.

Mueller-Dombois, D. and H. Ellenberg, 1974. Aims and Methods of Vegetation Ecology. 1st Edn., John Wiley and Sons, New York, USA., ISBN-13: 978-0471622901, Pages: 570.

Philips, E.A., 1959. Methods of Vegetation Study. Henry Holt Co. Inc., New York, USA., Pages: 107.

Pickett, S.T.A. and P.S. White, 1985. The Ecology of Natural Disturbance and Patch Dynamics. Academic Press, New York, USA., ISBN-13: 9780125545211, Pages: 472.

Pimm, S.L. and P. Raven, 2000. Biodiversity: Extinction by numbers. Nature, 403: 843-845.

Puyravaud, J.P., D. Shridhar, A. Gaulier, S. Aravajy and S. Ramalingam, 1995. Impacts of fire on a dry deciduous forest in the Bandipur National Park. Southern India: Preliminary assessment and simplification for management. Curr. Sci., 68: 745-748.

Rajdeep, P. Soni, L. Singh and B.B. Rana, 2011. Floristic diversity in ecologically restored lime stone mines and natural forests of Mussoorie and Doon Valley, India. Ecologia, 1: 44-55.

Singh, J.S. and P.S. Yadava, 1974. Seasonal variation in composition, plant biomass and net primary productivity of a tropical grassland at Kurukshetra. India Ecol. Monogr., 44: 351-375.

Soni, P., H.B. Vasistha and O.M. Kumar, 1994. Revegetation of an Abandoned Limestone Mine in Mussoorie Hills. In: Advances in Forestry Research in India, Prakash, R. (Ed.). International Book Distributers, Dehradun, India.