Research Paper

Volume : 4 | Issue : 5 | May 2015 • ISSN No 2277 - 8179

Studies In Siltara Industrial Area, Raipur, Chhattisgarh I - Herbaceous Vegetation

Botany

KEYWORDS : Siltara, Industrial area, Herbs, Phytosociology.

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ABSTRACT

Siltara is the industrial area located some about 15 km away from the Raipur city on Raipur-Bilaspur Road located at about 21022 N and 81039 E. There are two industrial sites in Siltata, one on the left and another on the right side of the road, named as: Siltara I and Siltara II. Almost all types of industries, from small to relatively large are located within the area. However, most of them are sponge iron factories. Most prominent of the area is the air pollution. Presently herbaceous vegetation of the area was studied, with the help of 1 x 1 m square quadrats, for their phytosociology. The area was surveyed three times in a year in the months of January, June and October, 2014 with 25 quadrats during each survey, totalling 75 quadrats during one year period. Dust, deposited over the plants were also collected for determining the proportion of combustible and non-combustible matter, by heating at about 2000C for about 2 hours. The industrial area has aquatic as well as land vegetation. Aquatic vegetation has developed in water pools formed due to accumulation of effluent water. Some of the herbs have clumped distribution while most of them have random distribution. In total 87 species of herbs, including some fern species, have been identified from the industrial area. On the basis of Importance Value Index (IVI) Parthenium hysterophorus, Alternanthera tenella, Malachra capitata and Hyptis suaveolens with IVI values of 30.17, 28.02, 13.33 and 12.29, respectively have been found to be the most dominant species. Thus the herbaceous flora of the industrial area is dominated by the alien, invasive species. All the plants have deposition of dust on their surface during the dry period of the year, but is washed away on the rainy days. The species recorded from the industrial area indicates that the variety of species is no where less than the variety of species recorded from outside the industrial area. Growth of the plants, apparently, does not show any significant difference from the growth of plants growing out side the industrial area. The observation, thus, suggests that the atmospheric dust from the industries in Siltara have no any significant effect of the growth of herbaceous vegetation in the industrial area. The dust was found to consist of about 20 percent combustible matter while about 80 percent of the dust was found to be non-combustible, mostly silica.

Introduction

Environmental pollution is any discharge of material or energy into water, land, or air that causes or may cause acute (short-term) or chronic (long-term) detriment to the Earth's ecological balance or that lowers the quality of life. Pollution and development are almost always correlated, positively. Industrialization has its beginning since the beginning of the eighteenth century and since then, till now, industries are the major sources of pollution. To restrict pollution in limited areas, it has now become customary to identify areas for locating industries. Siltara is a similar area located near Raipur city, the capital city of Chhattisgarh state, where a large number of industries have been located. Siltara is the industrial area located some about 15 km away from the Raipur city on Raipur-Bilaspur Road located at about $21^0$22 N and $81^0$39 E. There are two industrial sites in Siltata, one on the left and another on the right side of the road, named as: Siltara I and Siltara II. Almost all types of industries, from small to relatively large are located within the area. However, most of them are sponge iron factories. Most prominent of the area is the air pollution. There are as many types of gaseous effluents as there are types of industries. More apparent is the dust pollution, depositing on every structure in and beyond the industrial area. With the human inhabitants of the area plants are other sufferers of the dust pollution. Present studies were made therefore to analyze the herbaceous vegetation within the Siltara industrial area.

Material and methods:

Vegetation:

The industrial area has both the land area as well as some aquatic areas, formed mainly by waste water channels. Aquatic vegetation has developed along these water channels. Aquatic vegetation was recorded only for their presence. During present studies, however, only terrestrial, herbaceous vegetation were surveyed for their phytosociological parameters. Herbaceous vegetation of the area was studied for three seasons viz: winter, summer and after rains. Survey was made in the months of January (winter), June (summer) and October (after rains), 2014 with 25 quadrats during each survey, totaling 75 quadrats during one year period. The data was analysed for importance value index with following procedure:

$$\text{Frequency (\%)} = \frac{\text{No. of sampling plots in which the species is present}}{\text{Total No. of plots sampled}} \times 100$$

$$\text{Density (Ha}^{-1}\text{)} = \frac{\text{No. of individuals of the species}}{\text{Total area sampled (ha)}}$$

$$\text{Abundance} = \frac{\text{No. of individuals of the species}}{\text{No. of sampling units in which the species is present}}$$

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

$$\text{Relative Density} = \frac{\text{Density of the species}}{\text{Density of all the species}} \times 100$$

$$\text{Relative abundance} = \frac{\text{Abundance of the species}}{\text{Abundance of all the species}} \times 100$$

IVI = Relative frequency + Relative density + Relative abundance

2. Shannon index of diversity: Shanon index of diversity has also been named as Shannon Weaver index, Shannon Weiner index bur it is only Shanon index as has been given originally by Shanon (1947). Ignorant about this paper of Shannon, some people name it as Shanon Weaver index, on the basis of the paper published in co-authorship in 1948 (Spellerberg and Fedor,

2003).

Shannon index (H) = - ∑pi ln pi

Where:

Pi = importance value of ith species

ln = Natural logarithm

3. Simpson' index: Simpson' index has been calculated following Simpson (1949) using the formula:

Simpson's index of dominance (D) = $\sum pi^2$

Where: pi = value for ith species

Gini Simpson index of diversity: Gini Simpson index of diversity was calculated following Jost (2006)

Gini–Simpson index = 1-D

Simpson's reciprocal index = 1/D

K dominance plot, rank abundance plot and rarefaction plots have been plotted using Biodiversity Professional version 2, software.

A large number of articles, papers and books are available on different types of diversity indices, their calculation and interpretations. Some of them are: Allen, et al., 2009, Chao, 1984, 2005, Chao et al., 2014, Chao and Jost, 2012, Chiarucci, et al., 2008, Coleman, et al. 1982, Colwell, 2009, Colwell, et al. 2012, Colwell and Coddington, 1994, Gotelli and Colwell, 2011, Hill, 1973, Jost, 2006, 2007, Krebs, 1999, MacArthur and Wilson,1967, Magurran, 2004, Pielou, 1975, Tipper, 1979 and Whittaker, 1965).

Analysis of dust

Dust was collected from the plant surfaces. This collected dust was heated, at 200^{0}C for 2 hours in a silica crucible, cooled and then the proportion of combustible material was determined as follows:

(Weight of crucible + Dust) – (Weight of crucible + Weight of heated dust)

Result and discussion:

Herb flora of the industrial area had prostrate as well as erect species. Some of the herbs like *Blumea lacera* have clumped distribution while most of them have random distribution. The herbaceous flora of the area had several notorious exotics, also. In total 85 species of herbs, including some fern species, have been identified from the industrial area. On the basis of Importance Value Index (IVI) Parthenium *hysterophorus, Alternanthera tenella, Malachra capitata* and *Hyptis suaveolens* with IVI values of 30.17, 28.02, 13.33 and 12.29, respectively have been found to be the most dominant species. Thus the herbaceous flora of the industrial area is dominated by the alien, invasive species.

Table 1: IVI of herbs

SN	Species	Fre	Den	Abu	RF	RD	RA	IVI
1	Abutilon indicum G. Don.	2.67	0.04	1.5	0.26	0.10	0.46	0.81
2	Achyranthes aspera L.	17.33	0.32	1.85	1.66	0.77	0.56	2.99
3	Adiantum lunulatum Burm.	2.67	0.39	14.5	0.26	0.94	4.41	5.60
4	Aerva lanata Juss.	10.67	0.11	1	1.02	0.27	0.30	1.59
5	Aeschynomene aspera L.	1.33	0.01	1	0.13	0.02	0.30	0.46
6	Ageratum conyzoides L.	14.67	0.6	4.09	1.40	1.45	1.24	4.09
7	Alternanthera sessilis Br.	4	0.09	1.75	0.38	0.22	0.53	1.13
8	Alternanthera tenella	33.33	6.16	32.84	3.18	14.86	9.98	28.02
9	Alysicarpus monilifer DC.	5.33	0.12	2.25	0.51	0.29	0.68	1.48
10	Alysicarpus vaginalis DC.	22.67	0.25	1.12	2.17	0.60	0.34	3.11
11	Amaranthus spinosus L.	6.67	0.15	2.5	0.64	0.36	0.76	1.76
12	Ammania baccifera L.	30.67	0.68	2.22	2.93	1.64	0.67	5.24
13	Aneilema nudiflorum Br.	4	0.13	3.33	0.38	0.31	1.01	1.71
14	Aneilema spiratum Br.	6.67	0.17	1.6	0.64	0.41	0.49	1.53
15	Angiopteris evecta Hoffm.	6.67	0.15	2.2	0.64	0.36	0.67	1.67
16	Argemone Mexicana L.	2.67	0.07	2.5	0.26	0.17	0.76	1.18
17	Bidens biternata (Lour.) Merr. et Sherff. Ex Sherff.	21.33	0.37	1.75	2.04	0.89	0.53	3.46
18	Biophytum sensitivum DC.	4	0.19	4.66	0.38	0.46	1.42	2.26
19	Blumea lacera (Burm f.) DC.	6.67	0.09	1.4	0.64	0.22	0.43	1.28
20	Blumea oxyodonta	34.67	1.34	4.04	3.31	3.23	1.23	7.77
21	Boerhaavia diffusa L.	6.67	0.07	1	0.64	0.17	0.30	1.11
22	Cassia occidentalis	41.33	1.09	2.65	3.95	2.63	0.81	7.38
23	Celosia argentea L.	1.33	0.01	1	0.13	0.02	0.30	0.46
24	Chorchorus trilocularis L.	2.67	0.03	1	0.26	0.07	0.30	0.63
25	Cleome viscosa L.	12	0.37	3.11	1.15	0.89	0.94	2.98
26	Commelina bengalensis L.	9.33	0.48	5.14	0.89	1.16	1.56	3.61
27	Convolvulus nummularius	5.33	0.09	1.75	0.51	0.22	0.53	1.26
28	Cosmos	1.33	0.03	2	0.13	0.07	0.61	0.81
29	Crotalaria alata Ham.	4	0.25	3.33	0.38	0.60	1.01	2.00
30	Crotalaria pallida Aiton.	2.67	0.29	11	0.26	0.70	3.34	4.30
31	Croton bonplandianum Baill.	1.33	0.13	10	0.13	0.31	3.04	3.48
32	Cynoglossum denticulatum DC.	29.33	0.44	1.5	2.80	1.06	0.46	4.32
33	Datura metel	8	0.28	3.5	0.76	0.68	1.06	2.50

SN	Species	Fre	Den	Abu	RF	RD	RA	IVI
34	Desmodium triflorum DC.	21.33	1.12	5.25	2.04	2.70	1.60	6.33
35	Echinops echinatus Roxb.	1.33	0.01	1	0.13	0.02	0.30	0.46
36	Eclipta alba Hassk.	4	0.09	2.33	0.38	0.22	0.71	1.31
37	Emilia sonchifolia	14.67	0.19	1.23	1.40	0.46	0.37	2.23
38	Euphorbia geniculata Orteg.	5.33	0.09	1.75	0.51	0.22	0.53	1.26
39	Euphorbia hirta L.	16	0.31	1.92	1.53	0.75	0.58	2.86
40	Euphorbia neriifolia L.	9.33	0.11	1.14	0.89	0.27	0.35	1.50
41	Evolvulus alsinoides L.	10.67	0.17	1	1.02	0.41	0.30	1.73
42	Glossogyne pinnatifida DC.	10.67	0.23	2.12	1.02	0.55	0.64	2.22
43	Grangea maderaspatana Poir.	13.33	0.17	1.3	1.27	0.41	0.39	2.08
44	Heliotropium indicum L.	6.67	0.21	3.2	0.64	0.51	0.97	2.12
45	Hygrophila auriculata (Schum.) Heine.	16	1	6.25	1.53	2.41	1.90	5.84
46	Hyptis suaveolens Poit,	34.67	2.73	7.88	3.31	6.58	2.39	12.29
47	Impatiens balsamina L.	12	0.63	5.22	1.15	1.52	1.59	4.25
48	Indigofera enneaphylla L.	22.67	0.76	3.35	2.17	1.83	1.02	5.02
49	Indigofera linifolia Retz.	21.33	0.68	3.2	2.04	1.64	0.97	4.65
50	Justicia simplex, Don.	9.33	0.21	2.29	0.89	0.51	0.70	2.09
51	Leonotis nepetifolia (L.) R. Br.	10.67	0.47	4.4	1.02	1.13	1.34	3.49
52	Malachra capitata	2.67	0.95	35.5	0.26	2.29	10.79	13.33
53	Merremia tridentata	5.33	0.17	3.25	0.51	0.41	0.99	1.91
54	Murdannia spirata	4	0.48	9	0.38	1.16	2.73	4.27
55	Ocimum basilicum, L.	10.67	0.16	1.2	1.02	0.39	0.36	1.77
56	Ocimum sanctum L.	9.33	0.13	1.43	0.89	0.31	0.43	1.64
57	Oldenlandia corymbosa, L.	8	0.17	1.62	0.76	0.41	0.49	1.67
58	Oxalis corniculata	6.67	0.47	7	0.64	1.13	2.13	3.90
59	Parthenium hysterophorus.	80	8.07	10.08	7.64	19.46	3.06	30.17
60	Phyla nodiflora (L.) Greene.	10.67	0.2	1.9	1.02	0.48	0.58	2.08
61	Phyllanthus debilis, Ham.	20	0.93	4.7	1.91	2.24	1.43	5.58
62	Phyllanthus niruri, L.	2.67	0.06	1	0.26	0.14	0.30	0.70
63	Phyllanthus simplex	9.33	0.33	3.57	0.89	0.80	1.08	2.77
64	Physalis minima, L.	13.33	0.13	1	1.27	0.31	0.30	1.89
65	Polygonum glabrum	2.67	0.03	1	0.26	0.07	0.30	0.63
66	Rhyncosia sp.	2.67	0.4	20	0.26	0.96	6.08	7.30
67	Ruellia tuberose L.	4	0.05	1.33	0.38	0.12	0.40	0.91
68	Rungia repens , Nees.	4	0.17	4.33	0.38	0.41	1.32	2.11
69	Scoparia dulcis, L.	29.33	0.37	1.27	2.80	0.89	0.39	4.08
70	Sesbania aegyptiaca, Pers.	13.33	0.36	2.7	1.27	0.87	0.82	2.96
71	Sida acuta , Burm.	2.67	0.03	1	0.26	0.07	0.30	0.63
72	Sida cordifolia	17.33	0.2	1.15	1.66	0.48	0.35	2.49
73	Solanum xanthocarpum, Schrad & Wendl.	5.33	0.13	2.5	0.51	0.31	0.76	1.58
74	Sonchus arvensis, L.	12	0.12	1	1.15	0.29	0.30	1.74
75	Spermacoce hispida, L.	6.67	0.16	2.4	0.64	0.39	0.73	1.75
76	Spermacoce stricta	10.67	0.13	1.25	1.02	0.31	0.38	1.71
77	Tephrosia purpurea, Pers.	6.67	0.08	1	0.64	0.19	0.30	1.13
78	Trichodesma indicum (L.) R. Br.	28	0.56	2.14	2.68	1.35	0.65	4.68
79	Tridax procumbens, L.	14.67	0.32	2.18	1.40	0.77	0.66	2.84
80	Triumfetta annua, L.	5.33	0.07	1.25	0.51	0.17	0.38	1.06
81	Urena lobata, L.	26.67	0.35	1.3	2.55	0.84	0.39	3.79
82	Vernonia cinerea, Less.	17.33	0.36	2.08	1.66	0.87	0.63	3.16
83	Vinca pumilla	1.33	0.01	1	0.13	0.02	0.30	0.46
84	Xanthium strumarium, L.	40	0.61	1.53	3.82	1.47	0.46	5.76
85	Zornia gibbosa, Spanoghe.	9.33	0.53	5.55	0.89	1.28	1.69	3.86
86		1046.68	41.46	329.12	100	100	100	300

Abbreviations

Fre = Frequency
RD = Relative density
Den = Density
RA = Relative abundance
Abu = Abundance
IVI = Importance value index
RF = Relative frequency

Values for different indices were as follows:
Shannon index of diversity =3.9788
Simpson's index of dominance (D) = 0.0316
Gini Simpson index of diversity = 0.9684
Simpson's reciprocal index = 31.6458

The K- abundance plot having a rising trend indicates that there

is no evenness in the distribution of individuals among the species. The Rank abundance plot, with a rapid falling trend indicates high level of dominance in the herbaceous community of the industrial area, while the Rarefaction plot, not approaching asymptote, indicates that the present sampling efforts have not been sufficient for the area (Fig. 1).

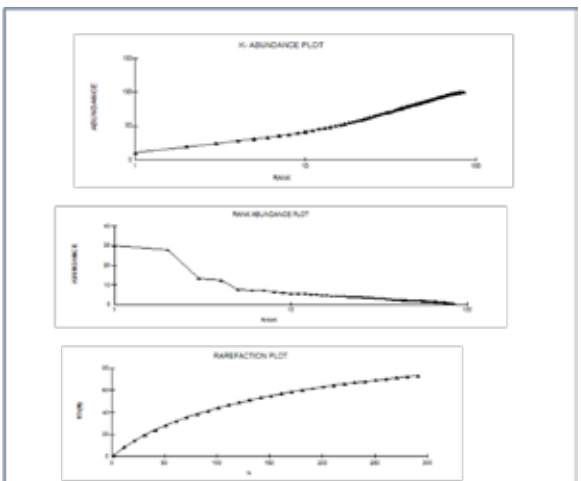

Fig. 1: K- Abundance plot, Rank abundance plot and Rarefaction curve for herbs

The dust was found to consist of about 20 percent combustible matter while about 80 percent of the dust was found to be non-combustible, mostly silica.

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