The spatial distribution of trees outside forests in some selected regions of Rajgarh, Madhya Pradesh

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Abstract

Trees outside forests (TOF) have crucial ecological and social-economic roles in rural and urban contexts around the world. The present study aims to make a large-scale estimation framework to assess ecological diversity of Trees outside forests in some regions of Rajgarh district, Madhya Pradesh. Species have been identified following regional and local floras. GPS was used for registering geographical coordinates of the sampled plots. Systematic enumeration is provided for all the inventoried species. A total of 32 species of trees representing 19 families and 29 genera were recorded in the study area. Among them *Eucalyptus tereticornis* was the dominant (147), followed by *Acacia nilotica* (144 trees) and *Azadirachta indica* (129 trees). The Shanon-Wiener diversity index (H) for the transects was 1.96, Evenness (E) was 1.01and Simpson index (D) was 6.99. The study indicates the availability of higher level of species diversity in Rajgarh, Madhya Pradesh.

Keywords: Tree species, Diversity, Transect, Forest, Geographical regions.

Introduction

Global warming and biodiversity loss are the two important currently debated issues among the world's scientists and policy makers (Alkemade et al., 2011), caused mainly by fossil fuel burning and deforestation during the last few decades (van der Werf et al., 2009). The last century finished with an increase in global temperature by 0.74 °C and the atmospheric CO_2 concentration of 379 ppm (UNFCCC, 2007; IPCC, 2013). Furthermore, atmospheric carbon dioxide would be doubled by 2050 if the current rate of increase continues and will lead to the global temperature rise of up to 2–4 °C (IPCC, 2013). A projection by IPCC (2013) revealed that by the end of 21st century the global sea level will rise by 28–98 cm due to melting of polar ice, which would badly alter low-lying coastal countries (e.g. Bangladesh, Maldives, The Netherlands) existence and livelihoods pattern. Forests retention, coupled with various reforestation and afforestation programmes, tropical in particular, can play an important role in mitigating global climate change through sequestering atmospheric carbon (Dixon et al., 1994; Jose, 2009; Kumar, 2011).

Trees outside Forests are defined as trees on land not defined as forest and other wooded land. Interestingly, there is evidence that the increase in on-farm tree numbers occurs in areas where population densities are high and farm size is very small (Leakey, 2010). From a local perspective, there may be more interest in maintaining and improving Trees outside Forests than forest lands especially if the improvement will benefit the farmers and the local community (Lund, 1999). Though people are getting benefits by favour of Trees outside Forests in form

of lumber, firewood, fruits honey and such products, little has been documented on their potential in carbon storage. Generally, the basic information such as location, number, species, spatial organization, biomass, growth and production is often lacking. Trees outside Forests are thus most often ignored in land-use planning and development policies (FAO, 2010).

At present, area-wise Madhya Pradesh is number one State in the country, having 76,429 sq. kilometers of its forest area. Next comes Andhra Pradesh with 68,019 sq. kilometers and third is Chhatisgarh with 55,998 sq. kilometers of forest area. Rajgarh district was constituted after the formation of Madhya Bharat in May 1948. The district is located at western part of Madhya Pradesh and is bounded by Shajapur district in the south as well as west. The district of Sehore, Bhopal, Guna and Jhalawar (Rajasthan) enclose it from the southeast, east, northeast, and north directions respectively. There are many areas in Rajgarh district with Trees outside forests. So the aim of the present study was to quantify and categorize the trees outside forest (TOF) in Rajgarh district.

Materials and Methods

A survey was conducted to record the trees outside forest in Rajgarh district. All row or line of trees growing linearly found along the roads, canals, rivers and railway tracks are classified under linear category. As sample plots were laid in rectangular fashion with dimensions of 100 x 10 m (i.e., 0.1 ha). Field Explorations were conducted during June, 2016 to April, 2019 covering all the non- forested seven Tehsils of the district. Representative specimens of all taxa inventoried in linear transect plots were collected in quadruplicates. Species have been identified following regional and local floras. GPS was used for registering geographical coordinates of the sampled plots. Systematic enumeration is provided for all the inventoried species. Nomenclature is updated following the latest version of the Plant list (The Plant List, 2012). Family delimitations are based on Angiosperm Phylogeny Group classification (AGP III, 2009), but arrangement of families is based on Bentham and Hooker's classification (Bentham and Hooker, 1862-83) has been followed. Trees outside forest were identified and categorized on the basis of their families and genera.

Results and Discussion

Millions of plants, animals, and microorganisms are present on earth in various ecosystems we called it biodiversity. Present definition considers genetic variation, species and ecosystem varieties as biodiversity (Pandya et al., 2013). Worldwide, the forests and species biodiversity and number of trees are being degraded, and every day cause of increasing demands of fuel-wood and timbers, and other agro-forestry practices including anthropogenic pressure on the ecosystem.

In the present study a survey was conducted to know the distribution of different tree species outside the forest in Rajgarh district. For this purpose data for different villages of seven Tehsils namely Rajgarh, Biora, Narsinghgarh, Sarangpur, Zirapur, Khilchipur and Pachore were collected with latitude, longitude and farmer's name. A total of 32 tree species namely *Dalbergia sissoo, Prosopis cineraria, Delonix regia, Millettia pinnata,*

Senegalia catechu, *Butea monosperma*, *Tamarindus indica*, *Eucalyptus tereticornis*, *Syzygium cumini*, *Psidium guajava*, *Tectona grandis*, *Acacia nilotica*, *Madhuca longifolia*, *Manilkara hexandra*, *Diospyros melanoxylon*, *Bambusa vulgaris*, *Azadirecta indica*, *Moringa oleifera*, *Ficus religiosa*, *Ficus benghalensis*, *Ficus racemosa*, *Santalum album*, *Citrus sinensis*, *Citrus limon*, *Aegle marmelos*, *Mangifera indica*, *Annona squamosa*, *Carissa carandas*, *Ziziphus mauritiana*, *Phyllanthus emblica*, *Punica granatum* and *Phoenix Dactylifera* were recorded in the studied site. The tree species were represented by a total of 19 families i.e. Fabaceae, Myrtaceae, Verbenaceae, Mimosaceae, Sapotaceae, Ebenaceae, Poaceae, Meliaceae, Moringaceae, Moraceae, Santalaceae, Rutaceae, Anacardiaceae, Annonaceae, Apocynaceae, Rhamnaceae, Phyllanthaceae, Punicaceae and Arecaceae. Details of the tree species with their local and botanical names are given in the following table 4.1.

Table 1 List of trees outside forest observed in Rajgarh district

S. no.	Family	Botanical name	Local name	Genera
1.	Fabaceae	*Dalbergia sissoo*	Sheesham	*Dalbergia*
		Prosopis cineraria	Khejdi	*Prosopis*
		Delonix regia	Gulmohar	*Delonix*
		Millettia pinnata	Karanj	*Millettia*
		Senegalia catechu	Khair	*Senegalia*
		Butea monosperma	Palash	*Butea*
		Tamarindus indica	Imali	*Tamarindus*
2.	Myrtaceae	*Eucalyptus tereticornis*	Eucalyptus	*Eucalyptus*
		Syzygium cumini	Jamun	*Syzygium*
		Psidium guajava	Amrood	*Psidium*
3.	Verbenaceae	*Tectona grandis*	Sagaun	*Tectona*
4.	Mimosaceae	*Acacia nilotica*	Babool	*Acacia*
5.	Sapotaceae	*Madhuca longifolia*	Mahua	*Madhuca*
		Manilkara hexandra	Khirni	*Manilkara*
6.	Ebenaceae	*Diospyros melanoxylon*	Tendu	*Diospyros*
7.	Poaceae	*Bambusa vulgaris*	Baas	*Bambusa*

8.	Meliaceae	*Azadirecta indica*	Neem	*Azadirecta*
9.	Moringaceae	*Moringa oleifera*	Sahjan	*Moringa*
10.	Moraceae	*Ficus religiosa*	Peepal	*Ficus*
		Ficus benghalensis	Bargad	*Ficus*
		Ficus racemosa	Gular	*Ficus*
11.	Santalaceae	*Santalum album*	Chandan	*Santalum*
12.	Rutaceae	*Citrus sinensis*	Santara	*Citrus*
		Citrus limon	Neebu	*Citrus*
		Aegle marmelos	Bel	*Aegle*
13.	Anacardiaceae	*Mangifera indica*	Aam	*Mangifera*
14.	Annonaceae	*Annona squamosa*	Seetafal	*Annona*
15.	Apocynaceae	*Carissa carandas*	Karonda	*Carissa*
16.	Rhamnaceae	*Ziziphus mauritiana*	Ber	*Ziziphus*
17.	Phyllanthaceae	*Phyllanthus emblica*	Aonla	*Phyllanthus*
18.	Punicaceae	*Punica granatum*	Anar	*Punica*
19.	Arecaceae	*Phoenix Dactylifera*	Khajur	*Phoenix*

Tree species

A total of 32 species of trees representing 19 families and 29 genera were recorded in the study area (Table 4.2). Among them *Eucalyptus tereticornis* was the dominant (147), followed by *Acacia nilotica* (144 trees) and *Azadirachta indica* (129 trees). *Madhuca Longifolia* was totally absent in the Zirapur transect while *Manilkara hexandra* was absent in Khichlipur transect. Among all tree species, *Santalum Album* was found to be lowest number (4) and was totally absent in Biora, Sarangpur, Zirapur and Pachore transects.

Rajgarh transect

In the Rajgarh transect a total of 344 individuals were recorded. Among them *Eucalyptus tereticornis* trees were found to be present in the highest number (28) followed by twenty two trees of *A. nilotica*, *A. indica* and *P. guajava* each. In this transect lowest number of *B. vulgaris(1), S. Album(1)* and *Carissa Carandas(1)* trees were recorded.

Biora transect

A total of 343 individuals were found in the Biora transect. Among all the highest number of trees of *A. nilotica* (27) and *A. indica* (27) were noticed. In this transect single tree of *M. Longifolia* was found. *S. album* was found to be tatally absent in Biora transect (Table 4.2).

Narsinghgarh transect

In the Narsinghgarh transect a total of 332 individuals of tree species were found. Among all these individuals the highest number of trees of A. nilotica (26) followed by *E. tereticornis* (22) *P. gujava* (22) and *P. granatum* (22) were found to be present respectively. *Z. mauritiana* was found to be lowest in number (1) in this transect.

Table 2 Transect-wise record of tree species observed in Rajgarh district during the present investigation (TR=Rajgarh transect, TB= Biora transect, TN=Narsinghgarh transect, TS=Sarangpur transect, TZ=Zirapur transect, TK=Khichlipur transect, TP=Pachore transect).

Botanical Name	**TR**	**TB**	**TN**	**TS**	**TZ**	**TK**	**TP**	**Total**
Eucalyptus tereticornis	28	18	22	24	13	17	25	**147**
Dalbergia sissoo	11	3	12	8	5	7	6	**52**
Tectona grandis	18	14	16	11	16	8	5	**88**
Acacia nilotica	22	27	26	18	22	13	16	**144**
Prosopis cineraria	15	12	8	7	6	8	10	**64**
Delonix regia	8	5	9	7	11	3	4	**47**
Madhuca Longifolia	3	1	5	3	0	1	4	**17**
Diospyros Melanoxylon	5	7	9	6	8	4	2	**41**
Bambusa vulgaris	1	6	5	7	2	3	8	**30**
Manilkara hexandra	2	5	7	3	2	0	3	**22**
Millettia Pinnata	2	5	6	4	1	3	5	**26**
Senegalia catechu	8	9	6	8	7	10	3	**51**
Butea monosperma	12	11	4	6	11	3	6	**53**
Azadirachta indica	22	27	11	15	17	19	18	**129**
Moringa oleifera	8	2	13	5	12	6	9	**55**
Ficus religiosa	8	11	10	5	6	4	4	**48**

Ficus Benghalensis	2	8	9	11	7	8	6	**51**
Santalum Album	1	0	2	0	0	1	0	**4**
Ficus Racemosa	4	6	9	11	3	4	7	**44**
Citrus Sinensis	14	12	5	8	11	7	9	**66**
Mangifera indica	16	18	13	12	8	7	8	**82**
Annona Squamosa	12	6	8	7	11	4	5	**53**
Carissa Carandas	1	10	5	8	6	9	7	**46**
Ziziphus mauritiana	11	14	1	8	8	9	4	**55**
Citrus limon	17	5	12	11	16	8	3	**72**
Phyllanthus emblica	19	12	15	4	14	8	7	**79**
Syzygium cumini	10	8	7	9	12	11	12	**69**
Psidium guajava	22	23	22	15	14	16	11	**127**
Punica granatum	11	24	22	11	17	13	9	**107**
Aegle marmelos	12	12	8	7	5	9	13	**66**
Tamarindus indica	11	13	14	8	12	10	12	**80**
Phoenix Dactylifera	8	9	11	8	7	10	8	**61**
Total	**344**	**343**	**332**	**275**	**290**	**243**	**249**	**2076**

Sarangpur transect

Sarangpur transect had totally 275 individuals of tree species. In this transect the highest 24 trees of *E. tereticornis* were found to be present. S. album was totally absent in this transect (Table 4.2).

Zirapur transect

In Zirapur transect a total of 290 individuals of tree species were present. Among all individuals the highest 22 trees of *A. nilotica* were found to be present. Individuals of two tree species *M. longifolia* and *S. album* were found to be totally absent in Zirapur transect (Table 4.2).

Khichlipur transect

A total of 243 tree individuals were present in Khichlipur transect. Among all *A. indica* (19) individuals were found in highest numbers followed by 17 individuals of *E. tereticornis*. *M. hexandra* was found to be totally absent in this transect (Table 4.2).

Pachore transect

In Pachore transect a total of 249 individuals of different tree species were recorded. In this transect the highest number of individuals of *E. tereticornis* (25) were found. *S. album* was found to be totally absent in this transect (Table 4.2).

Shanon-Wiener diversity index, Evenness and Simpson index in different transects

The highest numbers of tree individuals were found in Rajgarh transect (343) followed by Biora transect (342). The lowest numbers of tree individuals were observed in Khichlipur transect (243). The Shanon-Wiener diversity index (H) for the transects was 1.96, Evenness (E) was 1.01and Simpson index (D) was 6.99 (Table 4.3).

Table 3 Shanon-Wiener diversity index and Simpson index in different transects

Transects	**Number of individuals (n)**	**Pi**	**Pi^2**	***ln* Pi**	**Pi *ln* Pi**
TR	344	0.166	0.028	-1.795	-0.298
TB	343	0.165	0.027	-1.801	-0.297
TN	332	0.159	0.025	-1.838	-0.292
TS	275	0.132	0.017	-2.024	-0.296
TZ	290	0.139	0.019	-1.973	-0.274
TK	243	0.117	0.013	-2.145	-0.250
TP	249	0.119	0.014	-2.128	-0.253
Total	**2076**	**1**	**0.143**	**-13.704**	**-1.96**

Shanon index (H) = 1.96, H_{max} = *ln*(S) = *ln*(7) = 1.95, *Evenness (E)* = 1.96 /1.95 = 1.01, *Simpson index (D)* = 6.99

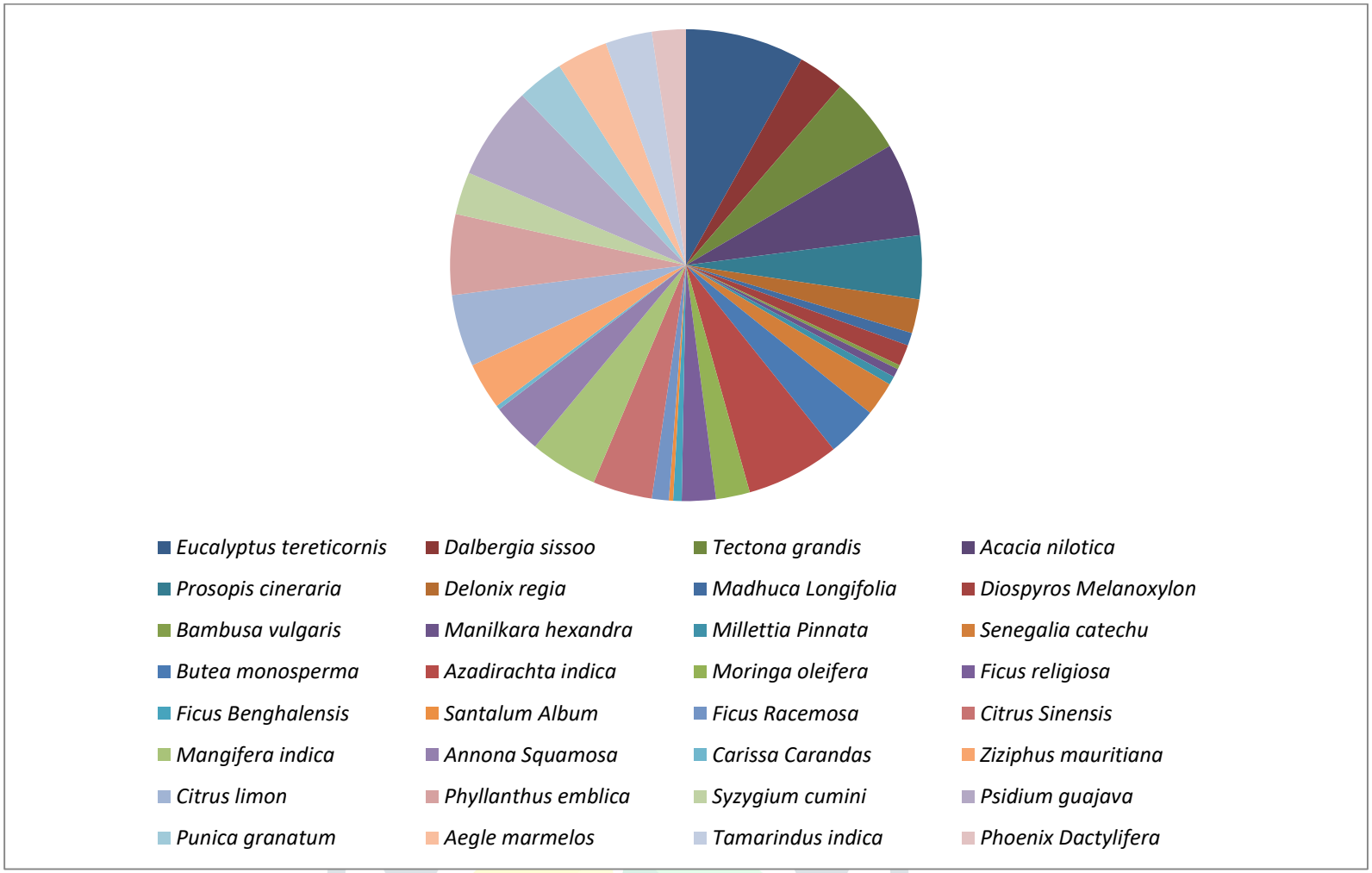

Figure 1. Distribution pattern of different tree species in Rajgarh transect

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