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Assessment of Tree Diversity of Forests in Hadagarh Wildlife Sanctuary, Odisha, India

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ABSTRACT

The study in Hadagarh Wildlife Sanctuary, Odisha, has assessed the diversity pattern of trees along with other phyto-sociological parameters in periphery, buffer and core areas. A total number of 63 species of trees belonging to 59 genera and 30 families were documented. *Shorea robusta*, showed dominance in all the sites except in one site of the periphery region of the sanctuary where *Azadirachta indica* recorded highest Important value Index (IVI) value of 61.45 followed by *Shorea robusta* with IVI of 46.329. Other co-dominant species e.g. *Terminalia alata*, *Symphorema polyandrum*, *Ixora pavetta* had intermediate values of IVI in different regions. Variation in species richness and abundance was observed across the studied areas which can be fairly attributed to human interventions in terms of collection of firewood, timber species, grazing of domestic animals and significantly encroachments and dependence of human population residing inside the sanctuary on the forests. Only one site in buffer areas displayed heterogeneous character whereas others showed homogeneous character in terms of the distribution of species according to various frequency classes. Better ecological values are still intact in relatively inaccessible forests of the sanctuary. This study and its outcome may serve as baseline tool of future conservation strategies for researchers, regulators and policy makers.

Keywords: Biotic interference, Forest resource, IVI, Socio-economic value, Tribal.

INTRODUCTION

The study of the vegetation by phyto-sociological methods has been recognised as scientific and systematic assessments to help us understand the state of various structural and functional characters of ecosystem and their surroundings. The type, quantity and stratification of vegetation are crucial to understanding the pattern and structure of the ecosystem. The significance of such focused studies has increased as depletion of biodiversity and deterioration of environmental quality is being felt all across the globe. Developmental activities are to meet needs and aspirations of the ever-increasing population. This has undoubtedly put tremendous pressure on the natural resources to safeguard ecological stability in various key ecosystems and to protect and preserve our forest resources, the policies have been made to constitute network of protected areas like national

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parks, sanctuaries, biosphere reserves. The present study has been carried out on the forests of Hadagarh Wildlife Sanctuary located on the eastern part of the state of Odisha, India. There are two other protected areas adjoining this sanctuary i.e. Kulidhia Wildlife Sanctuary and Similipal Biosphere Reserve.

The forest cover in the State of Odisha is 51,345 sq km of which 6,967 sq km is very dense forest, 21,370 sq km moderately dense forest and 23,008 sq km open forest. The forest cover in the State constitutes 32.97% of the geographical area. The vegetation of present sanctuary is a part of the Eastern Ghats forests which runs along the Indian coast passing through states of Odisha, Andhra Pradesh and Tamil Nadu. There are a very few phyto-sociological studies conducted in Eastern Ghats and particularly in the Hadagarh WL Sanctuary except Rout *et al.* (2018), Bhadra and Pattanayak (2019) who carried out works on tree Species Population Dynamics in the Tropical Dry Deciduous Forest of Odisha.

Forests have always been important sources of sustenance for various life forms and play a crucial role in maintaining livelihoods of our population both including tribal and urban ecosystem (Kumar *et al.* 2018). Hadagarh Wildlife Sanctuary is one of such area in India where many villagers are dependent on its forest resources for their day to day requirements for a long time. The study on effects of human interferences/disturbances and climate change on forest dynamics and plant demography in this protected area needs to be scientifically done to help implementing a sound ecological improvement plan as highlighted by several researchers (Edwards *et al.* 2014, Sati and Bandooni 2018, Souza and Longhi 2019). The forest fire, overgrazing, lopping of trees for fodder and firewood and removal of leaf and wood litters from the forest floor have been found to affect plant diversity (Malik and Bhatt 2016). We have no such phyto-sociological studies reports for the forests of Hadagarh sanctuary including the impact sources and remedial measures needed. This study, therefore attempts to find out the status of composition and structure of the vegetation of Hadagarh Sanctuary.

MATERIALS AND METHODS

Study area

The Hadagarh Wildlife Sanctuary was notified by the Government of Odisha on 06.12.1978. It has an

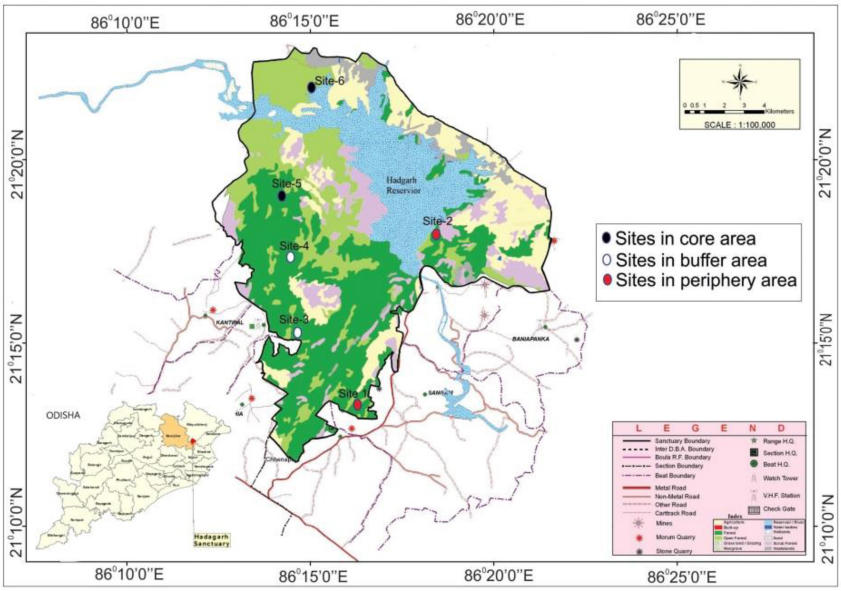

Fig. 1. Location map of study area. (Source-Odisha Wildlife Organisation, 2020 and www. wildlife. odisha.gov.in).

Fig. 2. View of the sanctuary area adjoining Hadgarh reservoir.

area of 191.06 sq km (Longitude 86°10' to 86°22' E Latitude 21°23' to 21° 12 'N) (Figs. 1-3). The sanctuary is situated in the districts of Keonjhar and Mayurbhanj. River Salandi, one of the major tributaries of river Baitarani passes through it. Hadagarh Reservoir and Salandi dam is one of the important features of the sanctuary apart from the landscape with miscellaneous vegetation and smaller hills containing variety of flora and fauna. The forest type of this area has been categorised as Dry Peninsular Sal Forests and Northern dry mixed deciduous forests (Champion and Seth 1968). The entire landscape is an ideal habitat for many wild flora and fauna. The valley comprises of Hadagarh reservoir and its catchments. The tribal population in villages is dominated by Santhals and Hos. The study area is also frequented by natural calamities like droughts, floods and cyclones.

The annual average rainfall is 1718 mm to 2369 mm. The maximum temperature ranges from 35º Celsius to 37º Celsius while the minimum temperature

Fig. 3. View of the Sanctuary study area.

ranges from 6º Celsius to 8º Celsius. The air in this area is very humid with relative humidity generally exceeding 60%. The soil type is mainly sandy loam. Quartzite, Quartz and schists laterite types of rocks are found in this area. The trend of disasters affecting the entire district shows that duration of floods and cyclones in the year is observed during June to October and March to December respectively while tornado is frequented throughout the year (Anonymous 2020).

Vegetation data analysis

Random sampling plots were identified for the study and sampling of vegetation was done once for one year (2013-14) during summer (March – May). Similar observation continued for the 2nd year also. Systematic survey was carried out for all trees ≥ 30 cm diameter at breast height (DBH). The size and number of quadrats, collection of data were based on standard ecological methods (Misra 1968, Kershaw 1973). A total of 20 quadrats were sampled of 10 m × 10 m size for each site. Total six sites (two each from periphery, buffer and core) areas were analyzed by this method. Law of frequency was expressed as A>B>C>=< D<E (Raunkiaer 1934). The phyto-sociological parameters were estimated following (Philips 1959, Curtis 1959). Specimen were identified with the help of Working Plan (WP 2008-2017) of Keonjhar Forest Division, Flora of Orissa (Saxena and Brahmam 1996), Botany of Bihar and Orissa (Haines 1925) and herbarium of Department of Botany, Utkal University, Bhubaneswar, India.

RESULTS

The assessment found 63 species of trees belonging to 59 genera and 30 families in different vegetation areas across periphery, buffer and core areas of the sanctuary. A comparison reveals, Site 5 and Site 2 recorded maximum number of species having maximum number of genera and families amongst the vegetation layer of these strata. Site 6 and Site 1 recorded less species richness in view of the total number of species found in the sampling areas on the basis of comparison with other sites. Site 6 was found to contain less number of families when compared to other study sites.

The present area has similar representation as in other areas of the country except Similipal where tree species are far greater than these forests. The most abundant families were Rubiaceae, Verbenaceae, Combretaceae, Dipterocarpaceae, Myrtaceae and Mimosaceae. The variations in dominance and distribution of tree species in this forest type can be attributed to climatic conditions like rainfall, temperature besides intensities of varied anthropogenic pressures. Amongst the peripheral sites studied, *Azadirachta indica* recorded the highest IVI followed by *Shorea robusta*, *Schleichera oleosa* and *Tamarindus indica* at Site 1 whereas *Shorea robusta* showed the highest IVI followed by *Terminalia alata*, *Morinda tinctoria* and *Careya arborea* at Site 2 (Tables 1-2). Similarly, amongst the buffer sites i.e. area having relatively less anthropogenic interferences *Shorea robusta* had the highest IVI followed by species like *Symphorema polyandrum* at both Sites 3 and 4 (Tables 3-4). The analysis of sites located in core areas where probability of human interferences are the least under ideal conditions indicated *Shorea robusta* having highest IVI followed by *Ixora pavetta*, *Xantolis tomentosa* and *Mitragyna parvifolia*. Whereas another area i.e. Site 6 recorded *Shorea robusta* with highest IVI followed by *Eucalyptus tereticornis*, *Flacourtia jangomas* and *Sterospermum suaveolens* (Tables 5-6). All other species were found to have intermediate IVI values.

Therefore, all the sites under study except for the peripheral site-1, *Shorea robusta* was the dominant tree species present with maximum IVI of 141 at Site 6 one of the core areas of the sanctuary. The lowest IVI was recorded for *Catunaregam spinose* and *Randia dumetorum* at Sites 1 and 4 respectively. Higher IVI values are generally considered as an indication of a better adaptation in a habitat amongst the species present. This adaptation is further due to the result of their growth and formation of association and communities. Thus *Shorea robusta* which is the dominant species in the study area has different species associated with it at different study sites which can be described as the co dominants in the sanctuary. The other codominant species thus associated with

Table 1. Species, family, RD, RF, RBA and IVI of Peripheral Site-1 of Hadagarh Sanctuary.

Scientific name	Family	RD	RF	RBA	IVI
Azadirachta indica A Juss., Mem	Meliaceae	30.43	26.32	4.71	61.46
Shorea robusta Gaertn. f. Fruct	Dipterocarpaceae	21.74	21.05	3.54	46.33
Schleichera oleosa (*Lour*.) *Oken*	Sapindaceae	1.45	2.63	32.59	36.68
Tamarindus indica L. *Sp. Pi*	Caesalpinlaceae	5.80	2.63	26.16	34.59
Naringi crenulata (*Roxb*.) *M. Roem.*	Rutaceae	2.90	5.26	23.92	32.08
Lannea corromandelica (*Houtt*)	Anacardiceae	11.59	10.53	2.54	24.66
Strychnos nux-vomica (L.)	Strychnaceae	5.80	7.89	0.98	14.67
Eucalyptus tereticornis Sm. Spec	Myrtaceae	5.80	2.63	4.12	12.55
Protium serratum (*Wall. ex Colebr*)	Burseraceae	2.90	5.26	0.18	8.34
Cassia fistula L. *Sp. Pl*	Caesalpinlaceae	2.90	5.26	0.01	8.17
iospyros malabarica (*Desr.*) *Kostel*	Ebenaceae	2.90	2.63	0.23	5.76
Cycas circinalis L.*var.orixensis*	Cycadaceae	2.90	2.63	0.01	5.54
Acacia nilotica L.	Mimosaceae	1.45	2.63	0.74	4.82
Catunaregam spinosa (Thunb.) Tirveng.	Rubiaceae	1.45	2.63	0.27	4.35

Shorea robusta are *Azadirachta indica, Schleichera oleosa, Naringi crenulata, Lannea corromandelica* and others at Site 1, *Terminalia alata, Morinda tinctoria, Careya arborea, Diospyros malabaric*a, *Alstonia scholaris* among others at site 2, *Randia dumetorum*, *Anogeissus latifolia, Combretum decan-*

Table 2. Species, family, RD, RF, RBA and IVI of Peripheral Site-2 of Hadagarh Sanctuary.

Scientific name	Family	RD	RF	RBA	IVI
Shorea robusta Gaertn. f.	Dipterocarpaceae	27.50	9.68	9.72	46.90
Terminalia alata Heyne, ex Roth.	Combretaceae	10.00	6.45	29.97	46.42
Morinda tinctoria Roxb.	Rubiaceae	7.50	9.68	2.30	19.48
Careya arborea Roxb.	Lecythidaceae	2.50	3.23	9.83	18.05
Diospyros malabarica (Desr.) Kostel	Ebenaceae	5.00	6.45	4.574	16.025
Alstonia scholaris (L.) R. Br.	Apocynaceae	2.50	3.23	9.29	15.02
Argyreia setosa Roxb. Choisy	Convolvulaceae	2.50	3.23	7.99	13.72
Albizia lebbeck L. Benth.	Mimosaceae	2.50	6.45	1.72	13.17
Haldinia cordifolia (Roxb.) Ridsd.	Rubiaceae	5.00	6.45	3.86	12.82
Adina cordifolia (Roxb.) Ridsd.	Rubiaceae	5.00	3.23	6.80	12.52
Lagerstroemia parviflora Roxb.	Lythraceae	2.50	6.45	0.55	9.50
Gmelina arborea Roxb.	Verbenaceae	2.50	3.23	2.97	8.70
Syzigium cumini (L.) Skeels.	Myrtaceae	2.50	3.23	2.39	8.12
Lannea corromandelica					

Table 2. Continued.

Scientific name	Family	RD	RF	RBA	IVI
(Houtt) Merr.	Anacardiceae	2.50	3.23	1.76	7.48
Aegle marmelos L. *Corr.*	Rutaceae	2.50	3.23	1.12	6.85
Garuga pinnata Roxb.	Burseraceae	2.50	3.23	1.06	6.79
Ichnocarpus frutescens (L.) R. Br.	Apocynaceae	2.50	3.23	0.90	6.63
Oroxylum indicum (L.) Vent.	Bignoniaceae	2.50	3.23	0.86	6.59
Madhuca indica Gmel.	Sapotaceae	2.50	3.23	0.59	6.32
Diospyros melanoxylon Roxb.	Ebenaceae	2.50	3.23	0.47	6.19
C*esearia elliptica* Willd.	Flacourtiaceae	2.50	3.23	0.44	6.16
Cleistanthus collinus (Roxb.) Benth ex Hook. f.	Euphorbiaceae	2.50	3.23	0.44	6.16

drum, Holarrhena antidysenterica and others at Site 3, *Lagerstroemia parviflora*, *Bombax ceiba, Grewia tiliifolia, Schleichera oleosa, Cassia fistula* and others at Site 4, *Ixora pavetta*, *Xantolis tomentosa*, *Mitragyna parvifolia, Clerodendrum viscosum, Terminalia chebula Lannea corromandelica* among others at Site 5 and *Eucalyptus tereticornis*, *Flacourtia jangomas, Sterospermum suaveolens* and others at Site 6. The distribution of species according to various frequency classes indicated the vegetation of homogeneous character except for one site in buffer area which was heterogeneous (Table 7).

DISCUSSION

We observed that *Diospyros ebenum*, *Acacia nilotica Azadirachta indica*, *Strychnosnux-vomica*, *Andrographis paniculata*, *Holarrhena antidysenterica*, *Smilax macrophylla*, *Asoaragus racemosus*, *Xantolis tomentosa*, *Syzigium cumini*, *Terminalia bellirica* have socio-economic importance for the local tribal population residing within and adjoining areas of the sanctuary. The tribal population derive their major chunk of sustenance from these forest resources resulting in varied anthropogenic pressures on the composition and functioning of ecosystem services. Site 1, a peripheral site has greater IVI for *A. indica* than *S. robusta* and other forest species as being closed to human habitation than buffer or core sites. At site 2 also, IVI of *S. robusta* is much lower than same species at sites 3, 4, 5 and 6. The present study area has similar representation as reported from a tropical dry deciduous forest in Bhadra Wildlife Sanc-

Table 3. Species, family, RD, RF, RBA and IVI of Buffer area (Site-3) of Hadagarh Sanctuary.

Name of species	Family	RD	RF	RBA	IVI
Shorea robusta Gaertn. f.	Dipterocarpaceae	39.62	22.58	40.87	103.07
Croton oblongifolius Roxb.	Euphorbiaceae	13.21	12.90	11.91	38.02
Anogeissus latifolia (Roxb. ex DC) Wall	Combretaceae	7.55	9.68	13.20	30.43
Randia dumetorum (Retz) Poir	Rubiaceae	7.55	12.90	5.87	26.32
Albizia procera (Roxb.) Benth	Mimosaceae	3.77	6.45	9.35	19.57
Combretum decandrum Roxb.	Combretaceae	5.66	9.68	3.61	18.94
Schleichera oleosa Lour. Oken	Sapindaceae	5.66	3.23	1.02	9.91
Mangifera indica L.	Anacardiaceae	1.89	3.23	4.35	9.47
Holarrhena antidysenterica Wall.	Apocynaceae	3.77	3.23	2.05	9.05
Cassia fistula L.	Caesalpinlaceae	3.77	3.23	1.74	8.74
Hymenodictyon orixense (Roxb.) Mabb.	Rubiaceae	1.89	3.23	1.82	6.93
Pterospermum acerifolium (L.) Willd.	Sterculiaceae	1.89	3.23	1.56	6.67
Bridelia retusa (L.) Spreng.	Euphorbiaceae	1.89	3.23	1.56	6.67
Haldinia cordifolia (Roxb.) Ridsd.	Rubiaceae	1.89	3.23	1.32	6.43

Table 4. Species, family, RD, RF, RBA and IVI of Buffer area (Site-4) of Hadagarh Sanctuary.

Scientific name	Family	RD	RF	RBA	IVI
Shorea robusta Gaertn. f.	Dipterocarpaceae	45.78	16.28	29.19	91.25
Croton oblongifolius Roxb.	Euphorbiaceae	13.25	9.30	20.91	43.47
Terminalia alata Heyne, ex Roth.	Combretaceae	2.41	4.65	4.06	20.60
Albizia lebbeck (L.) Benth.	Mimosaceae	1.20	2.33	7.90	17.29
Artocarpus lacucha Roxb. ex Buch.	Combretaceae	7.23	9.30	5.97	14.24
Grewia tiliifolia Vahl, Symb.	Tiliaceae	4.82	6.98	2.14	13.94
Cassia fistula L.	Caesalpinlaceae	2.41	9.30	1.80	13.60
Schleichera oleosa Lour. Oken	Sapindaceae	4.82	6.98	1.71	13.43
Bombax ceiba L.	Bombaceae	2.41	6.98	9.64	13.17
Strychnos potatorum L. f.	Strychnaceae	3.61	4.65	6.18	12.04
Holarrhena antidysenterica Wall.	Apocynaceae	2.41	4.65	1.31	9.58
Careya arborea Roxb.	Lecythidaceae	3.61	4.65	2.31	9.37
Lagerstroemia parviflora Roxb.	Moraceae	1.20	2.33	1.11	8.18
Terminalia bellirica (Gaertn.) Roxb.	Combretaceae	1.20	4.65	2.12	5.65
Syzigium cumini (*L.*) *Skeels*	Myrtaceae	1.20	2.33	1.44	4.97
Pavetta indica L.	Rubiaceae	1.20	2.33	1.37	4.89
Randia dumetorum (Retz.) Poir.	Rubiaceae	1.20	2.33	0.64	4.17

tuary, Karnataka by Krishnamurthy *et al.* (2010) and tropical dry deciduous forests of Birbhum District, West Bengal (Pradhan and Rahaman 2015). Mishra *et al.* (2012) in a study of the Similipal Biosphere Reserve recorded *Shorea robusta* as the dominant species having IVI of 77.67 followed by *Terminalia alata* (16.13) and *Anogeissus latifolia* (13.43). Another study on phyto-sociological evaluation of Kuldiha Wildlife Sanctuary found *Terminalia tomentosa* having the highest IVI followed by *Shorea robusta*

Table 5. Species, family, RD, RF, RBA and IVI of Core area (Site-5) of Hadagarh Sanctuary.

Scientific name	Family	RF	RBA	RD	IVI
Shorea robusta Gaertn. f.	Dipterocarpaceae	15.63	25.09	28.89	69.61
Xantolis tomentosa (Roxb.) Raffin.	Sapotaceae	12.50	11.70	11.11	35.31
Ixora pavetta Andr	Rubiaceae	3.13	23.43	2.22	28.77
Mitragyna parvifolia (Roxb.) Korth.	Rubiaceae	9.38	3.39	8.89	21.65
Clerodendrum viscosum Vent.	Verbenaceae	6.25	3.81	4.44	14.50
Terminalia chebula Retz.	Combretaceae	3.13	7.47	2.22	12.82
Careya arborea Roxb.	Lecythidaceae	3.13	1.43	4.44	9.00
Croton oblongifolius Roxb.	Euphorbiaceae	3.13	1.21	4.44	8.78
Diospyros malabarica (Desr.) Kostel	Ebenaceae	3.13	1.21	4.44	8.78
Syzigium cumini (L.) Skeels	Myrtaceae	3.13	3.17	2.22	8.52
Lannea corromandelica (Houtt.) Merr,	Anacardiceae	3.13	3.17	2.22	8.51
Gmelina arboraea Roxb	Verbenaceae	3.13	3.08	2.22	8.43
Kydia calycina Roxb	Malvaceae	3.13	1.97	2.22	7.32
Ichnocarpus frutescens (L.) R. Br	Apocynaceae	3.13	1.70	2.22	7.05
Buchanania lanzan Spreng.	Anacardiaceae	3.13	1.57	2.22	6.92
Nyctanthes arbor-tristis L.	Oleaceae	3.13	1.27	2.22	6.62
Aglaia cucullate (Roxb.) Pellegrin	Meliaceae	3.13	1.22	2.22	6.56
Randia dumetorum (Retz.) Poir.	Rubiaceae	3.13	1.06	2.22	6.40
Chloroxylon swietenia DC. Prod.	Rutaceae	3.13	1.01	2.22	6.35
Pterospermum acerifolium (L.) Willd	Sterculiaceae	3.13	0.82	2.22	6.16
Terminalia alata Heyne, ex Roth	Combretaceae	3.13	0.64	2.22	5.99
Anogeissus latifolia (Roxb. ex DC.) Wall	Combretaceae	3.13	0.60	2.22	5.95

Table 6. Species, family, RD, RF, RBA and IVI of Core area (Site-6) of Hadagarh Sanctuary.

Species name	Family	RD	RF	RBA	IVI
Shorea robusta Gaertn. f. Fruct	Dipterocarpaceae	75.63	43.75	44.61	163.99
Eucalyptus tereticornis Sm.	Myrtaceae	7.56	6.25	45.89	59.70
Sterospermum suaveolens (Roxb.) DC.	Bignoniaceae	9.24	12.50	0.14	21.88
Tectona grandis L. f.	Verbenaceae	1.68	6.25	5.26	13.19
*Flacourtia jangomas (*Lour.) Raeuch.	Flacourtiaceae	0.84	6.25	2.55	9.64
Croton oblongifolius Roxb.	Euphorbiaceae	1.68	6.25	0.82	8.75
Madhuca indica Gmel.	Sapotaceae	1.68	6.25	0.15	8.08
Holarrhena antidysenterica Wall.	Apocynaceae	0.84	6.25	0.46	7.55
Acacia auriculiformis A. Cunn. ex Benth.	Mimosaceae	0.84	6.25	0.13	7.22

and *Anogeissus latifolia* amongst tree species (Rout *et al.* 2018). All these three protected areas i.e. Similipal Biosphere, Hadagarh and Kulidhia Wildlife Sanctuaries, located in the same biogeographic zone exhibited *Shorea robusta* and *Terminalia alata* as the dominant species in terms of IVI.

The seven most important species as per IVI of site 1 and 2 are important for tribal population for their medicinal, food and construction values. As such these species in periphery are protected by tribal population being useful to them. Most of these species have been used by the villagers for medicines and other purposes. Usages of such plants by native population have also been recorded in other studies (Chowdhury and Koike 2010, Kassam *et al.* 2011, Bajpai *et al.* 2016 and Rout *et al.* 2018). Unsustainable collection of above medicinal plants has placed them in threatened and vulnerable categories in Conservation Assessment and Management Plan (CAMP) of Odisha (Pattanaik *et al.* 2009). Factors like lack of awareness about long term sustainable utilization of resources and failure to provide alternatives to human population could not put a curb on illicit felling, increased instances of collection of timber, fuel wood, fodder, medicinal plants.

The tree species having low RD and RF need proper protection to grow as mother trees for regeneration. There are far lower percentage of old grown trees in the peripheral site. These species have shown good regeneration pattern in some of the areas of the study (Dash *et al.* 2020). Therefore, it is important to control anthropogenic activities in peripheral areas like overgrazing, encroachments, illegal felling (Anonymous 2008). The sites 3, 4, 5 and 6 located in buffer and core zones still have domination of *S. robusta* indicating the importance of keystone species in sustaining other growth forms as evident from IVI values. Introduction of exotic species like *Acacia* and *Eucalyptus* in the sanctuary might have also affected the regeneration and seedling establishment of native species. *Eucalyptus* has become second most important species at site 6 of the core area.

CONCLUSION

The sanctuary is rich in phyto-diversity but it has been facing anthropogenic pressures. The village

Table 7. Distribution of tree species with respect to frequency classes at study sites in Hadagarh Sanctuary.

Site (S)	Area	Raunkiaer's freequency class A (0–20)	B (21–40)	C (41–60)	D (61–80)	E (81–100)
Site 1	Periphery	11	1	2	0	0
Site 2		15	7	0	0	0
Site 3	Buffer	8	3	2	0	1
Site 4		5	8	3	1	0
Site 5	Core	18	1	1	1	1
Site 6		7	1	0	1	0

economy in this area is highly dependent on the available minor forest products and continued human interferences coupled with frequent natural hazards are responsible for the deterioration of vegetation quality in the sanctuary. The trees having low IVIs require immediate protection measures to develop a stock of species for good regeneration potential. The current impoverished forest ecosystem essentially requires proactive management interventions which can help in regeneration of species thereby restoring various ecosystem services in the area. Therefore, we recommend that more studies need to be carried out to suitably modify the current methodology adopted in forestry management.

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