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Exploring the ethnomedicinal knowledge, phytosociology and carbon sequestration potential of tree diversity in Remuna block, Balasore, Odisha

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Abstract
Global climate change, habitat degradation, and biodiversity loss present urgent challenges, necessitating a better understanding of the relationship between tree diversity, ecosystem function, and human well-being. This study examined tree species diversity in a tropical moist deciduous forest of Remuna Block, Balasore district, Odisha, India, focusing on phyto-sociological attributes, biomass and carbon stock dynamics, and macronutrient distribution. Ethnomedicinal uses of dominant species by local communities were also documented. A total of 30 sample plots (20 × 20 m each) recorded 422 individual trees across 39 species, 33 genera, and 17 families. Fabaceae was the most species-rich family (11 species), and *Shorea robusta* emerged as the most dominant species with the highest Important Value Index (IVI = 61.48), biomass (6508.32 tons), and carbon stock (3254.16 tons). *Ficus benghalensis* and *Ficus religiosa* were also notable biomass contributors, while *Syzygium cumini* showed the lowest values. Biomass estimation and nutrient analysis revealed that calcium was the most abundant nutrient in *Shorea robusta*, followed by nitrogen, potassium, magnesium, and phosphorus. Ethnobotanical surveys indicated widespread use of tree species in traditional medicine, with leaves being the most commonly used part (43%) for treating ailments such as fever, diabetes, skin conditions, and snake bites. The study provides essential data on forest structure, ecosystem services, and the cultural value of plant species, offering a scientific basis for local biodiversity conservation and the sustainable use of traditional ecological knowledge.

Keywords: Phytosociological, ethnomedicinal, ecosystem, biomass, macro nutrient, carbon stock, conservation

1. Introduction
Climate change and the rapid loss of biodiversity are environmental issues of the single decade change look in to 21st century. The increased demand for resources and the emerging human population have led to more extensive deforestation, especially in tropical regions and worsened the situation of climate change. This highlights the need for management practices that are conservation oriented, protective, restorative, and resilient to guarantee long-term sustainability ecosystem (Kumar *et al*., 2006) [1]. Changing forests into agricultural or urbanized areas interferes with the critical ecological functions nutrifying, hydrating, and carbon accumulating cycles. Along with this, the changes in land use reduces productivity of ecosystems and results in dramatic decrease of richness and resilience of species composing the ecosystem thus increasing their vulnerability to harsh climate changes (Srivastava *et al*., 2020) [24]. Even though the loss of forests compromises biodiversity, it also endangers the numerous livelihoods relying on the resources harvested from these ecosystems. Ecological restoration, sustainable forest management, and the integration of conservation objectives into international and domestic policies are some of the solutions needed to counter these threats. Protecting biodiversity and fostering ecosystem services will be key to ensuring the health and stability of our planet. The species composition and interactions within tropical forest ecosystems remain poorly understood, with new species being discovered daily and many others facing increasing threats.

Key characteristics of plant communities such as species composition, diversity, dominance, distribution patterns, and physiognomy play a critical role in defining ecosystem structure and function. Both natural and human-induced changes have the potential to drastically alter community stratification and ecological functionality (Suchiang *et al.*, 2020) [25]. A balanced ecosystem is one that is rich in diversity, exhibits interdependence among species, and remains sustainable over time. Conducting a phytosociological survey of tree species is essential for evaluating the structural and functional stability of these ecosystems. Forests play a vital role in the terrestrial carbon cycle, storing substantial amounts of biomass and contributing significantly to global carbon dynamics (Bonan, 2008) [2]. Understanding these processes is critical for ensuring the continued health and resilience of forest ecosystems, which are indispensable in regulating climate and maintaining biodiversity.

International communities are actively engaging in projects aimed at protecting biodiversity and preserving carbon reserves in tropical forests, which are responsible for storing more than 80% of the terrestrial vegetation's carbon dioxide (Van de Perre *et al.*, 2018) [28]. The global forest carbon stock is estimated at 861 ± 66 Pg C, with 30% stored in soil, 42% in living biomass, 10% in dead wood, and 5% in litter (Pan *et al.*, 2011) [18]. However, a range of anthropogenic pressures-including land-use changes, deforestation, habitat fragmentation, CO2 emissions, the spread of invasive species, resource overexploitation, and the broader impacts of climate change-are accelerating the decline of these critical ecosystems, putting them at increasing risk of rapid degradation and eventual extinction (Zhou *et al.*, 2006; Tan *et al.*, 2015) [29, 26]. The loss of tropical forests is not only a major concern for global biodiversity but also significantly disrupts the planet's carbon cycle, with far-reaching implications for climate regulation. Given these threats, it is crucial to monitor and document long-term changes in tree species composition. Such efforts are essential for understanding the response of tropical forests to climate change, assessing vegetation dynamics, and identifying key conservation priorities for maintaining these vital ecosystems.

A number of studies have been conducted to examine the vegetation structure, species composition, and regeneration status of tropical dry deciduous trees in eastern India, with a focus on understanding the impacts of human intrusion and species loss in these ecosystems (Narayan and Anshuali, 2015a; Gupta and Misha, 2019; Mastan *et al.*, 2020) [17, 7, 12]. Additionally, quantitative assessments of plant diversity in Odisha's tropical moist and dry deciduous forests have provided valuable insights into the ecological dynamics and the influence of environmental factors. Remuna, with its tropical climate characterized by high humidity and consistently hot temperatures, offers an environment conducive to the thriving of tree species. The climatic conditions have played a key role in the sustainable development and establishment of these species, which have adapted to the region's environmental challenges, contributing to the long-term stability of local ecosystems. 1) The objective of this study was to perform a comprehensive phytosociological analysis of tree species diversity in Remuna Block, focusing on key ecological parameters such as abundance, species density, frequency, and the Important Value Index (IVI). The findings aim to inform evidence-based management interventions for the conservation of biodiversity and the enhancement of local livelihoods through sustainable forest resource utilization and 2) to assess changes in biomass, carbon stocks, and the content of five major macronutrients in Remuna Block 3) To study the ethnomedicinal applications of tree species used by local communities**.**

2. Materials and Methods

2.1. Investigation site

Balasore, a coastal district in the northernmost part of Odisha, is geographically enclosed by the coordinates 21° 3' - 21° 59' N and 86° 20' - 87° 29' E (Muduli and Dhall, 2024) [15]. This district, characterized by its ethnic heterogeneity, is subdivided into twelve blocks. Notably, Remuna block represents a region with a substantial tribal demographic, located at 21.52'99" N and 86.88'35" E. Spatially, Remuna block covers 130 km², with a land use distribution of 99.54 km² classified as rural and 30.47 km² identified as urban areas.

2.2. Data collection

The study period, July 2019 to February 2020, was selected to ensure comprehensive coverage of vegetation phenology. Area surveys were performed based on a defined sampling strateg. Quadrat analysis was utilized for vegetation surveys. Tree species data were acquired via a random sampling methodology. Total Thirty (20 x 20 m) sample plots were established across varied sites within Remuna Block to quantify ecosystem structure, species composition, and above-ground tree biomassThe selection criteria for trees within these plots mandated a minimum diameter at breast height (DBH) ≥ 1.3 meters (Marimon *et al.*, 2002; Mishra *et al.*, 2013) [11, 13]. For trees with buttress roots, diameter at breast height (DBH) was measured above the buttress formations. Species were identified in the field using standard botanical keys and further verified with the regional reference The Flora of Orissa (Saxena & Brahman, 1994) [21]. To confirm taxonomic details such as accepted species names and family classifications, identifications were subsequently cross-checked using the online database *(*The Plant List 2013). Girth data were collected using a 10-meter flexible metric tape. The phytosociological parameters listed below were analysed using the methods and formulas described by Curtis (1959) [4] and Misra (1968):

$$\text{Density} = \frac{\text{Total number of individuals of a species in all quadrates}}{\text{Total number of quadrates studied}}$$

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

$$\text{Frequency (\%)} = \frac{\text{Number of quadrates in which the species occured}}{\text{Total number of quadrates studied}} \times 100$$

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

$$\text{Abundance} = \frac{\text{Total number of individuals of a species in all quadrates}}{\text{Total number of quadrates in which the species occured}}$$

$$\text{Relative Abundance} = \text{Relative Frequency} + \text{Relative Density}$$

$$\text{Relative Dominance} = \frac{\text{Total basal area of a species}}{\text{Total basal area for all species}} \times 100$$

IVI = Relative Density + Relative Frequency + Relative Dominance

Basal area(m^2) =Area occupied at breast height (1.3m) $=\pi\ (DBH/2)^2$

2.3 Population Structure

The population structure of plant species was assessed using the Girth at Breast Height (GBH) method, with measurements taken at 1.3 meters above ground level. Based on their DBH, individuals were assigned to specific size classes: 10–31 cm (saplings), 32–66 cm (bole stage), 67–101 cm (post-bole), 102–136 cm (mature trees), 137–171 cm (over-mature trees), and those exceeding 171 cm (old trees), following the classification system outlined by Saxena *et al*. (1984) [22]. The total number of individuals in each girth class was recorded, and the relative density (percentage) of individuals within each class was subsequently calculated to analyse population distribution patterns.

$$\text{Percent density} = \frac{\text{Number of individuals in each girth class}}{\text{Total number of individuals in all girth classes}} \times 100$$

2.4. Regeneration potential, biomass and nutrient contents:

The study quantified the regeneration potential of tree species within each Remuna Block based on Shankar's (2001) methodology. This involved determining the species frequency within distinct regeneration classes, with the proportional contribution of each class to the total species complement calculated to yield a percentage-based regeneration diversity index for each block

The calculator estimates the dry weight of a tree's above-ground portions—namely stem wood, foliage, branches, and bark—using diameter and height measurements, based on equations derived from thousands of samples (Lambert, M.-C.; Ung, C.-H.; Raulier, F., 2005) [10]. At the forest stand level, biomass and nutrient contents (including nitrogen, phosphorus, potassium, calcium, and magnesium) for these tree components are estimated using basal area, with models developed specifically for dominant species. These estimations can also be extended to individual species within mixed stands. For species not listed, or when species identification is uncertain, the model accommodates generalized categories such as broadleaf or coniferous stands (Lambert *et al*., 2005; Ung *et al*., 2008) [10, 27]. When evaluating nutrient depletion, species-specific variation is negligible for stem-only harvesting but becomes significant when branches and leaves are also removed. Despite this, forest managers have traditionally lacked the tools to integrate this consideration into harvest planning. The below-ground biomass (BGB) was calculated by multiplying the above-ground biomass by a root-to-shoot ratio of 0.26 (Cairns *et al*., 1997) [3]. Carbon content in biomass was assumed to be 50% of the total living biomass, following standard estimation practices (Ravindranath *et al*., 1997) [20].

3. Result and Discussion

Globally, terrestrial tree ecosystems support diverse biological communities, shaped by continuously changing landscapes and geoclimatic conditions (Herben *et al*., 2003) [8]. The spatial distribution of plant species within these ecosystems is a key indicator of ecological function and biomass dynamics (Enquist, 2002; Myklestad & Saetersdal, 2004) [5, 16]. To ensure effective and sustainable management of natural resources, it is essential to comprehend the floristic composition and habitat types of natural ecosystem (Ewald, 2003; Kumar *et al*., 2019) [6, 9].

In the present study of tropical forest composition in the Remuna Block, a total of 422 individual trees with a diameter at breast height (DBH) greater than 15 cm were recorded across 30 sample plots. These individuals represented 39 species, 33 genera, and 17 families. Among all species, *Ficus benghalensis* exhibited the highest DBH (779 cm), followed by *Ficus religiosa* (761 cm), *Tamarindus indica* (673 cm), *Azadirachta indica* (362 cm), *Ficus carica* (336 cm), and *Tectona grandis* (328 cm). Of the 39 recorded species, *Shorea robusta* showed a regular distribution pattern, while species such as *Pterocarpus marsupium*, *Tectona grandis*, and *Terminalia tomentosa* were observed to have a random spatial distribution. The analysis of tree species dominance based on the Importance Value Index (IVI) revealed that *Shorea robusta* was the most dominant species, with an IVI of 61.48, followed by *Pterocarpus marsupium* (16.89), *Terminalia tomentosa* (16.42), *Azadirachta indica* (14.95), and *Tectona grandis* (14.37). The species with the lowest IVI was *Lagerstroemia parviflora*, recorded at 1.22 (Table 1).

Family-wise distribution showed that Fabaceae was the most species-rich family, contributing 11 species to the recorded flora. This was followed by Combretaceae (5 species), Moraceae (4 species), and Rubiaceae (3 species). Other families, including Annonaceae, Meliaceae, and Sapotaceae, each contributed two species, while the remaining families were represented by a single species each (Figure 3). The distribution of regeneration potential across girth classes followed the pattern A < B < C < D < E > F, indicating an uneven population structure. A significant proportion of percent density was concentrated in mature (28.67%), over-mature (36.73%), and old trees (22.99%) (Table 3; Figure 4), suggesting the forest is in a late successional or climax stage. The predominance of mature and over-mature individuals over younger classes reflects limited regeneration and an aging tree population.

Among all tree species, the top five contributors to above-ground biomass were *Shorea robusta* (5165.34 tons), *Ficus benghalensis* (1308.72 tons), *Ficus religiosa* (1198.94 tons), *Pterocarpus marsupium* (1125.05 tons), and *Terminalia tomentosa* (921.72 tons), with the lowest biomass recorded for *Syzygium cumini* (6.61 tons) (Table 2). A similar trend was observed in carbon stock, where *Shorea robusta* stored the highest amount (3254.16 tons), followed by *Ficus benghalensis* (824.49 tons), *Ficus religiosa* (755.33 tons), *Pterocarpus marsupium* (708.78 tons), and *Terminalia tomentosa* (580.68 tons). The lowest carbon stock was found in *Syzygium cumini* (4.16 tons). With respect to macro-nutrient content, *Shorea robusta* demonstrated the highest accumulation across all tree components-stem wood, foliage, branches, and bark. The recorded nutrient values were: Nitrogen – 10.72 tons, Phosphorus – 1.35 tons, Potassium – 6.86 tons, Calcium – 15.41 tons, and Magnesium – 1.87 tons. In contrast, *Syzygium cumini* exhibited the lowest nutrient concentrations across all categories (Table 2). Calcium emerged as the most abundant nutrient across all tree species, attributed largely to the region's underlying lateritic and alluvial soils. These soils, part of the ancient Archaean geological system, are composed of laterite stone, basic granulites, intermediate to acidic charnockite veins, and Khondalite formations-some of the oldest rock structures, influencing nutrient dynamics in forest vegetation.

Several tree species are utilized by local communities in the Remuna Block for commercial and ethnomedicinal purposes.

Species such as *Azadirachta indica*, *Millettia pinnata*, and *Shorea robusta* are primarily harvested for oil extraction, while *Diospyros melanoxylon* is widely used for its leaves. A range of other species including *Aegle marmelos*, *Mangifera indica*, *Syzygium cumini*, *Tamarindus indica*, *Ziziphus mauritiana*, *Emblica officinalis*, *Madhuca indica*, *Terminalia bellirica*, and *Terminalia chebula* are commonly employed in traditional medicine due to their therapeutic properties. Ethnobotanical investigations have identified 108 medicinal plant species, spanning 98 genera and 56 families, traditionally used by local communities to treat various ailments (Muduli and Dhall, 2024) [15]. Specifically, 39 tree species were reported to be effective in managing common health issues such as colds, coughs, diarrhoea, diabetes, skin disorders, jaundice, acidity, earaches, abdominal and muscular pain, malaria, and vomiting (Table 4). Among the plant parts used for treatment, leaves are the most frequently utilized (43%), followed by stem bark (29%) and roots (10%) (Figure 5). These species serve as primary healthcare resources, especially for preliminary or first-aid treatments in rural and tribal areas where modern medical facilities are limited.

However, the availability of many medicinal plant resources is in decline due to unsustainable harvesting practices, a lack of awareness regarding conservation, and uncontrolled livestock grazing. These pressures not only threaten the ecological stability of the forest ecosystem but also contribute to the erosion of traditional knowledge systems that have been passed down through generations. The preservation of both plant biodiversity and indigenous ethnomedicinal knowledge is therefore critical for sustaining local health practices and ensuring long-term ecosystem resilience.

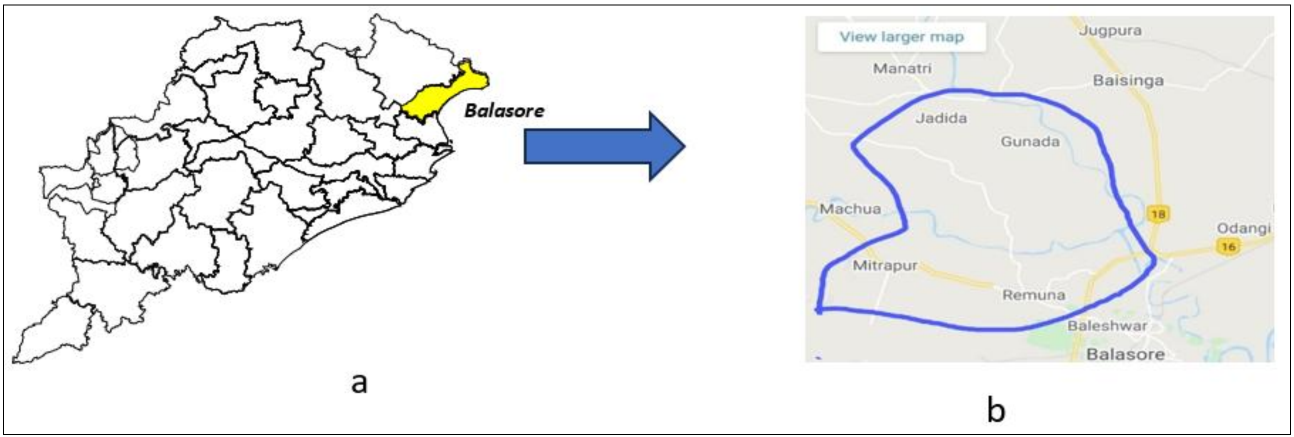

Fig 1: Map of the study area (a- Odisha, b-Remuna Block of Balasore District) source-Google

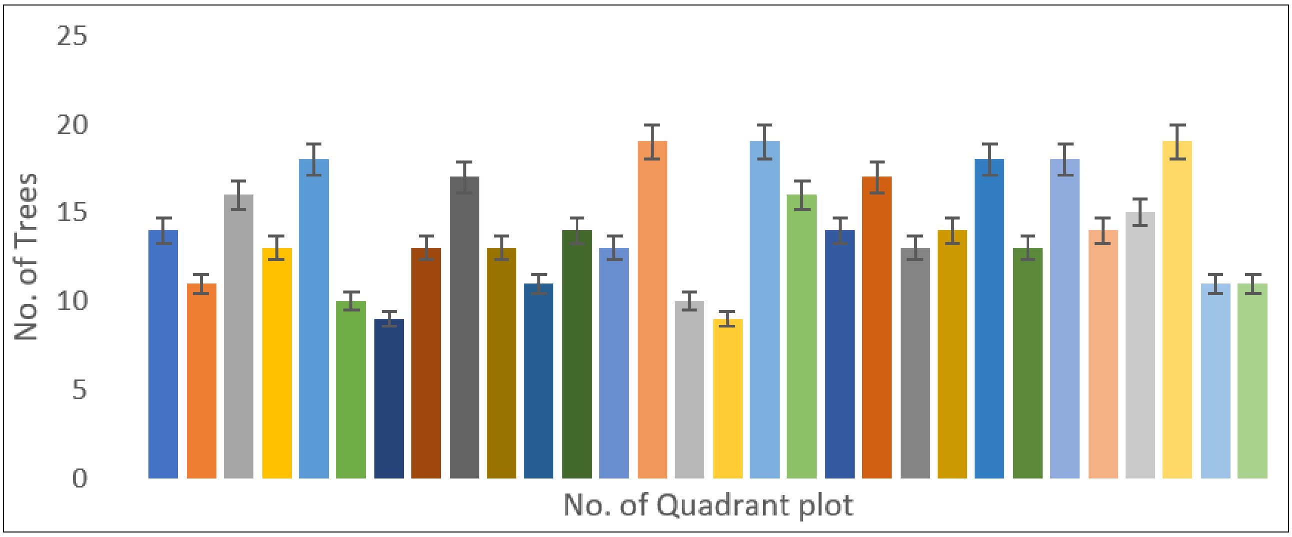

Fig 2: Plot wise distribution of tree diversity in Remuna Block, Balasore, Odisha

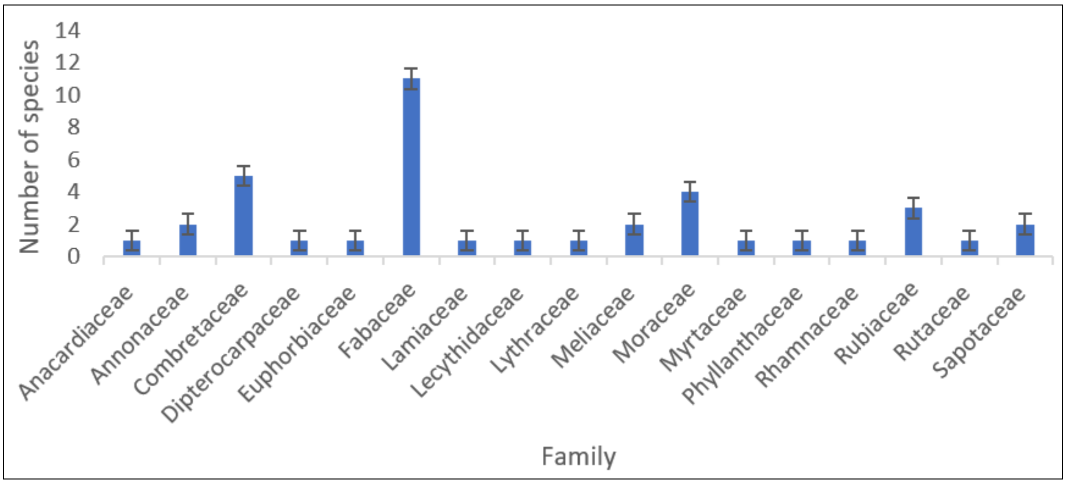

Fig 3: Family wise distribution of the species in study area

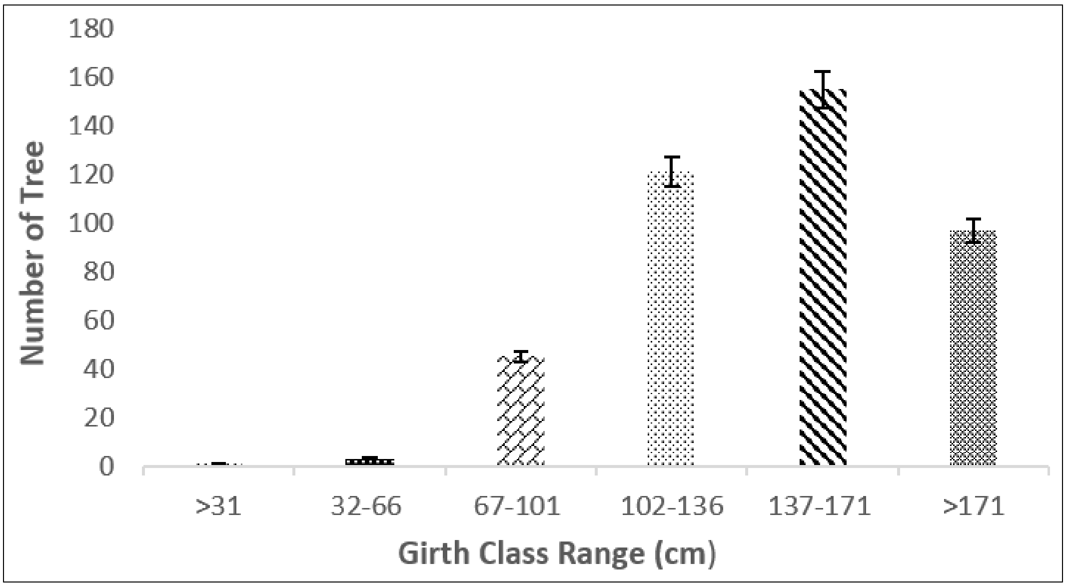

Fig 4: Girth classes of tree species

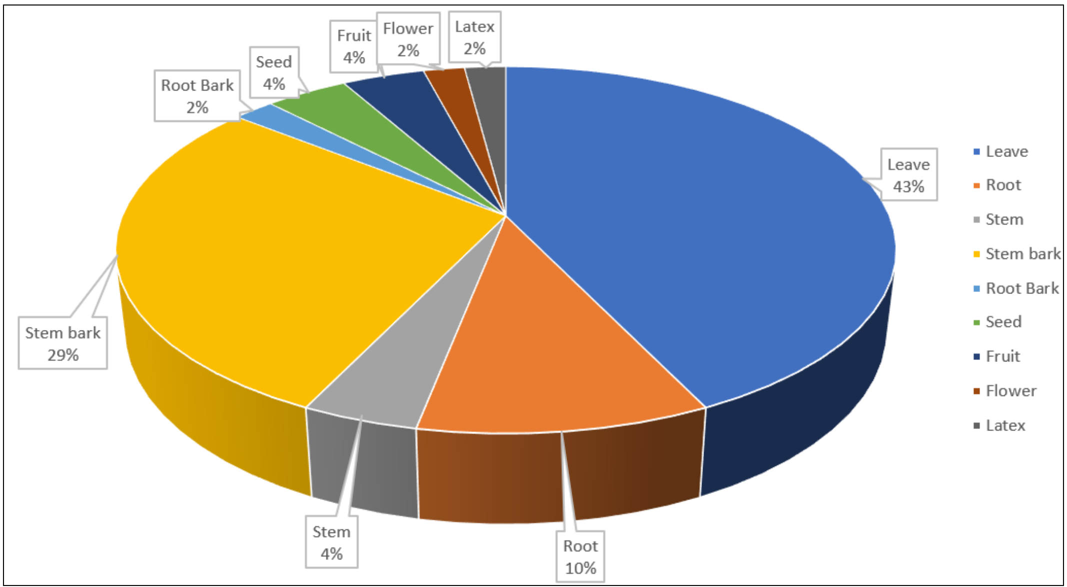

Fig 5: Different part of the plant used to local people for deferent Diseases

Table 1: Phytosociological analysis of tree species in Remuna, Balasore, Odisha

SL. No.	Botanical Name	Family	Local name	NOI	NPSO	D	RD	F	RF	AB	AB/F	RA	Relative Dominance	IVI
1	*Acacia auriculiformis* A.Cunn. ex Benth.	Fabaceae	Akashia	15	3	0.50	3.55	10.00	2.44	5.00	0.50	5.99	1.76	7.75
2	*Aegle marmelos* (L.) Correa	Rutaceae	Bela	5	2	0.17	1.18	6.67	1.63	2.50	0.38	2.81	0.35	3.16
3	Albizia lebbeck (L.) Benth	Fabaceae	Sirisa	12	3	0.40	2.84	10.00	2.44	4.00	0.40	5.28	1.83	7.11
4	*Anogeissus latifolia* (Roxb.ex.DC.) wall.ex Guill & per	Combretaceae	Dhaura	12	2	0.40	2.84	6.67	1.63	6.00	0.90	4.47	1.50	5.97
5	*Azadirachta indica* A.juss	Meliaceae	Neem	19	7	0.63	4.50	23.33	5.69	2.71	0.12	10.19	4.76	14.95
6	*Butea parviflora* Roxb.	Fabaceae	Palasha	7	2	0.23	1.66	6.67	1.63	3.50	0.53	3.28	1.07	4.35
7	*Careya arborea* Roxb.	Lecythidaceae	Kumbha	12	3	0.40	2.84	10.00	2.44	4.00	0.40	5.28	1.86	7.14
8	*Cassia fistula* L.	Fabaceae	Sunari	5	1	0.17	1.18	3.33	0.81	5.00	1.50	2.00	0.28	2.28
9	*Croton roxburghii* Balakr.	Euphorbiaceae	Putuli	2	1	0.07	0.47	3.33	0.81	2.00	0.60	1.29	0.12	1.41
10	*Dalbergia sisoo* Roxb.	Fabaceae	Sisso	12	4	0.40	2.84	13.33	3.25	3.00	0.23	6.10	2.67	8.77
11	*Diospyros melanoxylon* Roxb.	Fabaceae	Kendu	6	2	0.20	1.42	6.67	1.63	3.00	0.45	3.05	0.38	3.43
12	*Emblica officinalis* L.	Phyllanthaceae	Anola	4	2	0.13	0.95	6.67	1.63	2.00	0.30	2.57	0.25	2.82
13	*Ficus benghalensis* L.	Moraceae	Bara	5	4	0.17	1.18	13.33	3.25	1.25	0.09	4.44	5.86	10.30
14	*Ficus carica* L.	Moraceae	Dimiri	7	4	0.23	1.66	13.33	3.25	1.75	0.13	4.91	1.61	6.52
15	*Ficus elastica* Roxb.exHornem	Moraceae	Rabar	5	2	0.17	1.18	6.67	1.63	2.50	0.38	2.81	0.63	3.44
16	*Ficus religiosa* L.	Moraceae	Aswastha	8	2	0.27	1.90	6.67	1.63	4.00	0.60	3.52	5.86	9.38
17	*Haldina cordifolia* (Roxb.) Ridsdale	Rubiaceae	Kurma	12	3	0.40	2.84	10.00	2.44	4.00	0.40	5.28	2.87	8.15
18	*Lagerstroemia parviflora* Roxb.	Lythraceae	Sidha	1	1	0.03	0.24	3.33	0.81	1.00	0.30	1.05	0.17	1.22
19	*Madhuca indica* J.F. Gmel	Sapotaceae	Mahula	8	3	0.27	1.90	10.00	2.44	2.67	0.27	4.33	1.30	5.63
20	*Mangifera indica* L.	Anacardiaceae	Amba	10	3	0.33	2.37	10.00	2.44	3.33	0.33	4.81	2.02	6.83
21	*Miliusa velutina* (Dunal)Hook.f.& Thomas	Annonaceae	Parashi	11	2	0.37	2.61	6.67	1.63	5.50	0.83	4.23	1.32	5.55
22	*Millettia pinnata* (L.) Panigrahi	Fabaceae	Karanja	4	1	0.13	0.95	3.33	0.81	4.00	1.20	1.76	1.65	3.41
23	*Mimusops elengi* L.	Sapotaceae	Boula	4	2	0.13	0.95	6.67	1.63	2.00	0.30	2.57	0.36	2.93
24	*Mitragyna parvifolic* (Roxb.) Korth	Rubiaceae	Godikimia	3	2	0.10	0.71	6.67	1.63	1.50	0.23	2.34	0.89	3.23
25	*Neolamarckia cadamba* (Roxb.) Bosser	Rubiaceae	kadamba	5	2	0.17	1.18	6.67	1.63	2.50	0.38	2.81	0.30	3.11
26	*Polyalthia longifolia* Sonn.	Annonaceae	Debadaru	16	4	0.53	3.79	13.33	3.25	4.00	0.30	7.04	0.51	7.55
27	*Pterocarpus marsupium* Roxburgh	Fabaceae	Piasal	23	6	0.77	5.45	20.00	4.88	3.83	0.19	10.33	6.56	16.89
28	*Senegalia Senegal* (L.) Britton	Fabaceae	Babul	12	2	0.40	2.84	6.67	1.63	6.00	0.90	4.47	0.83	5.30
29	*Shorea robusta* Roth	Dipterocarpaceae	Sal	79	17	2.63	18.72	56.67	13.82	4.65	0.08	32.54	28.80	61.34
30	*Soymida febrifuga* (Roxb.) Juss	Meliaceae	Rohini	4	3	0.13	0.95	10.00	2.44	1.33	0.13	3.39	0.43	3.82
31	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamu	3	1	0.10	0.71	3.33	0.81	3.00	0.90	1.52	0.06	1.58
32	*Tamarindus indica* L.	Fabaceae	kainya	6	3	0.20	1.42	10.00	2.44	2.00	0.20	3.86	3.28	7.14
33	*Tectona grandis* L.f.	Lamiaceae	Saguan	23	5	0.77	5.45	16.67	4.07	4.60	0.28	9.52	4.85	14.37
34	*Terminalia arjuna* (Roxb.) Wight & Arn	Combretaceae	Arjuna	14	2	0.47	3.32	6.67	1.63	7.00	1.05	4.94	2.33	7.27
35	*Terminalia bellirica* (Gaertn.) Roxb.	Combretaceae	Bahada	6	3	0.20	1.42	10.00	2.44	2.00	0.20	3.86	0.76	4.62
36	*Terminalia chebula* Retz.	Combretaceae	Harida	8	5	0.27	1.90	16.67	4.07	1.60	0.10	5.96	3.19	9.15
37	*Terminalia tomentosa* Willd.	Combretaceae	Asana	25	6	0.83	5.92	20.00	4.88	4.17	0.21	10.80	5.62	16.42
38	*Xylia xylocarpa* Roxb. Taub.	Fabaceae	Kongada	3	1	0.10	0.71	3.33	0.81	3.00	0.90	1.52	0.66	2.18
39	*Ziziphus mauritiana* Lam.	Rhamnaceae	Barakoli	6	2	0.20	1.42	6.67	1.63	3.00	0.45	3.05	0.08	3.13

Note: NOI- Number of individuals, NPSO- Number of plots in which species occurred, D- Density, RD- Relative density, F- Frequency, RF-Relative frequency, AB- Abundance, RA- Relative Abundance, IVI- Importance value index

Table 2: Storage of Biomass, Carbon and 5 major macro nutrient contents (Nitrogen, Phosphorus, Potassium, Calcium and Magnesium) of the tree species in Remuna Block, Balasore, Odisha.

SL. No.	Botanical Name	Above ground biomass (in ton)	Below ground biomass (in ton)	Carbon storage (in ton)	Nitrogen (in ton)	Phosphorus (in ton)	Potassium (in ton)	Calcium (in ton)	Magnesium (in ton)
1	*Acacia auriculiformis*	256.1	66.58	161.34	0.54	0.06	0.34	0.77	0.09
2	*Aegle marmelos*	46.71	12.14	29.42	0.1	0.012	0.063	0.14	0.017
3	*Albizia lebbeck*	280.61	72.95	176.78	0.59	0.07	0.37	0.84	0.1
4	*Anogeissus latifolia*	220.55	57.34	138.94	0.46	0.05	0.29	0.66	0.08
5	*Azadirachta indica*	797.44	207.33	502.38	1.66	0.2	1.06	2.39	0.28
6	*Butea parviflora*	163.89	42.61	103.25	0.34	0.04	0.21	0.49	0.05
7	*Careya arborea*	284.92	74.07	179.49	0.6	0.074	0.381	0.859	0.103
8	*Cassia fistula*	36.54	9.5	23.02	0.07	0.009	0.049	0.112	0.013
9	*Croton roxburghii*	16.21	4.21	10.21	0.03	0.004	0.022	0.049	0.005
10	*Dalbergia sisoo*	437.21	113.67	275.44	0.91	0.114	0.583	1.313	0.15
11	*Diospyros melanoxylon*	49.74	12.93	31.33	0.1	0.013	0.067	0.152	0.018
12	*Emblica officinalis*	32.97	8.57	20.77	0.071	0.008	0.044	0.1	0.012
13	*Ficus benghalensis*	1308.72	340.26	824.49	2.68	0.34	1.72	3.86	0.47
14	*Ficus carica*	266.64	69.32	167.98	0.55	0.06	0.35	0.8	0.09
15	*Ficus elastica*	93.69	24.35	59.02	0.19	0.02	0.12	0.28	0.03
16	*Ficus religiosa*	1198.94	311.72	755.33	2.46	0.31	1.58	3.55	0.43
17	*Haldina cordifolia*	476.74	123.95	300.345	0.996	0.124	0.635	1.43	0.17
18	*Lagerstroemia parviflora*	27.07	7.03	17.05	0.056	0.007	0.036	0.081	0.009
19	*Madhuca indica*	201.89	52.49	127.19	0.425	0.53	0.27	0.608	0.073
20	*Mangifera indica*	325.97	84.75	205.36	0.68	0.085	0.43	0.98	0.11
21	*Miliusa velutina*	194.24	50.5	122.37	0.411	0.051	0.26	0.588	0.07
22	*Millettia pinnata*	255.49	66.42	160.955	0.53	0.06	0.34	0.77	0.09
23	*Mimusops elengi*	85.68	22.27	53.975	0.18	0.022	0.11	0.25	0.031
24	*Mitragyna parvifoli*	54.97	14.29	34.63	0.305	0.038	0.195	0.438	0.053
25	*Neolamarckia cadamba*	39.3	10.21	24.755	0.08	0.01	0.05	0.12	0.014
26	*Polyalthia longifolia*	58.01	15.08	36.545	0.12	0.015	0.079	0.179	0.049
27	*Pterocarpus marsupium*	1125.05	292.51	708.78	2.34	0.29	1.49	3.36	0.4
28	*Senegalia Senegal*	110.337	28.68	69.51	0.23	0.02	0.14	0.33	0.04
29	*Shorea robusta*	5165.34	1342.98	3254.16	10.72	1.35	6.86	15.41	1.87
30	*Soymida febrifuga*	70.53	18.33	44.43	0.147	0.018	0.094	0.211	0.025
31	*Syzygium cumini*	6.61	1.71	4.16	0.014	0.001	0.009	0.02	0.002
32	*Tamarindus indica*	636.31	165.44	400.875	1.31	0.16	0.84	1.89	0.23
33	*Tectona grandis*	786.83	204.57	495.7	1.64	0.2	1.05	2.36	0.28
34	*Terminalia arjuna*	361.6	94.01	227.805	0.76	0.09	0.48	1.09	0.13
35	*Terminalia bellirica*	112.6	29.27	70.935	0.23	0.02	0.15	0.34	0.04
36	*Terminalia chebula*	581.85	151.28	366.565	1.2	0.15	0.77	1.73	0.21
37	*Terminalia tomentosa*	921.72	239.64	580.68	1.92	0.24	1.22	2.76	0.33
38	*Xylia xylocarpa*	107.9	28.05	67.975	0.022	0.028	0.144	0.324	0.039
39	*Ziziphus mauritiana*	8.57	2.22	5.395	0.019	0.002	0.012	0.027	0.003

Table 3: Population Structure and Regeneration Potential of the tree species in Remuna Block, Balasore.

Sl. No.	Girth class	Range of centimeter	Dbh category	Number of plants	Percent density
1	A	10–31 cm	Sapling	1	0.24
2	B	32-66 cm	Bole	3	0.71
3	C	67-101 cm	Post bole	45	10.66
4	D	102-136 cm	Mature	121	28.67
5	E	137-171 cm	Over mature	155	36.73
6	F	>171 cm	Old trees	97	22.99

Table 4: List of important ethnomedicinal tree species used to Remuna peoples for preliminary treatment

SL. No.	Botanical Name	Family	Local name	Diseases	Part Used
1	*Acacia auriculiformis* A.Cunn. ex Benth.	Fabaceae	Akashia	Blood clotting Wound healing Diabetes	Leave Stem
2	*Aegle marmelos* (L.) Correa	Rutaceae	Bela	Diarrhoea Acidity	Leave Leave
3	*Albizia lebbeck* (L.) Benth	Fabaceae	Sirisa	Asthma Colds and coughs	flower
4	*Anogeissus latifolia* (Roxb.ex.DC.) wall. Ex Guill & per	Combretaceae	Dhaura	Dysentery Snake bite Leprosy, Diabetes Ulcers, Skin diseases	Leave
5	*Azadirachta indica* A.juss	Meliaceae	Neem	Malaria Chicken pox Jaundice	Leave Stem Bark
6	*Butea parviflora* Roxb.	Fabaceae	Palasha	Anthelmintic Digestive, piles	Leave
7	*Careya arborea* Roxb.	Lecythidaceae	Kumbha	Dysentery	Root
8	*Cassia fistula* L.	Fabaceae	Sunari	Arthritis Swelling	Leave
9	*Croton roxburghii* Balakr.	Euphorbiaceae	Putuli	Ringworm Wounds, Scabies and skin diseases	Stem bark Leave
10	*Dalbergia sissoo* Roxb.	Fabaceae	Sisso	Gonorrhoea and skin ailments	Leave Stem bark
11	*Diospyros melanoxylon* Roxb.	Fabaceae	Kendu	Leprosy fungal infections	Leave
12	*Emblica officinalis* L.	Phyllanthaceae	Anola	Eye sight weak	Leaf juice
13	*Ficus benghalensis* L.	Moraceae	Bara	Teeth pain	Milk latex
14	*Ficus carica* L.	Moraceae	Dimiri	Galactagogue	Fruit
15	*Ficus elastica* Roxb.exHornem	Moraceae	Rabar	Rheumatism Diarrhoea Hypertension	Leave Stem Bark Latex
16	*Ficus religiosa* L.	Moraceae	Aswastha	Skin disease	Stem bark
17	*Haldina cordifolia* (Roxb.) Ridsdale	Rubiaceae	Kurma	Skin diseases, wounds vomiting	Leave
18	*Lagerstroemia parviflora* Roxb.	Lythraceae	Sidha	Antidiabetic and ant obesity effects	Leave
19	*Madhuca indica* J.F. Gmel	Sapotaceae	Mahula	Diabetes Rheumatism,	Bark
20	*Mangifera indica* L.	Anacardiaceae	Amba	Blood dysentery	Stem bark
21	*Miliusa velutina* (Dunal)Hook.f.& Thomas	Annonaceae	Parashi	Cancer	Root
22	*Millettia pinnata* (L.) Panigrahi	Fabaceae	Karanja	Gonorrhoea Skin diseases	Root
23	*Mimusops elengi* L.	Sapotaceae	Boula	diarrhoea and dysentery	Stem Bark Fruit
24	*Mitragyna parvifoli* (Roxb.) Korth	Rubiaceae	Godikimia	Fever Muscular pain	Bark Root
25	*Neolamarckia cadamba* (Roxb.) Bosser	Rubiaceae	kadamba	Uterine complaints, blood disease	Leave Stem bark
26	*Polyalthia longifolia* Sonn.	Annonaceae	Debadaru	uterine disorders	Leave
27	*Pterocarpus marsupium* Roxburgh	Fabaceae	Piasal	Rheumatoid arthritis	Leave
28	*Senegalia Senegal* (L.) Britton	Fabaceae	Babul	colds, Diarrhoea	Leave Root
29	*Shorea robusta* Roth	Dipterocarpaceae	Sal	Ear pain	Stem
30	*Soymida febrifuga* (Roxb.) Juss	Meliaceae	Rohini	Leucorrhoea	Root bark
31	*Syzygium cumin* (L.) Skeels	Myrtaceae	Jamu	dysentery and diabetes	Seeds Stem Bark
32	*Tamarindus indica* L.	Fabaceae	kainya	wound healing Snake bites Abdominal pain	Leave

				Colds	
33	*Tectona grandis* L.f.	Lamiaceae	Saguan	Diabetes Inflammation Cancer	Leave
34	*Terminalia arjuna* (Roxb.) Wight & Arn	Combretaceae	Arjuna	Malaria	Stem bark
35	*Terminalia bellirica* (Gaertn.) Roxb.	Combretaceae	Bahada	Cough Diabetes Piles	Leave Fruit
36	*Terminalia chebula* Retz.	Combretaceae	Harida	Skin Disease. Diabetes Diarrhoea, High cholesterol	Stem bark Leave
37	*Terminalia tomentosa* Willd.	Combretaceae	Asana	Ulcers Diarrhoea	Bark
38	*Xylia xylocarpa* Roxb. Taub.	Fabaceae	Kongada	Leprosy Vomiting Diarrhoea Gonorrhoea	Fruits Seeds
39	*Ziziphus mauritiana* Lam.	Rhamnaceae	Barakoli	Abdominal pain during pregnancy	Stem bark

4. Conclusion

The study in Remuna Block highlights the ecological importance of older trees due to their higher biomass and carbon stock. While the forest shows strong regeneration, species with low IVI and juvenile trees need focused conservation. Despite its protected status, the area faces threats from human activity and overgrazing. Local communities rely on tree species for traditional medicine, emphasizing the need for awareness and regulation. Strengthening community involvement and conducting future monitoring are essential for sustainable forest management and biodiversity conservation.

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9. Declarations

All authors have read and understood the statement on the "Ethical Responsibilities of Authors" as outlined in the Instructions for Authors and affirm that they have complied with its provisions where applicable.

10. Declaration of competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

11. Data availability

Data will be made available on request.

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