

PLANT DIVERSITY IN DAK NONG PROVINCE, VIETNAM: A CASE STUDY IN DAK GLONG AND KRONG NO DISTRICT

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ABSTRACT

This study was conducted in Quang Son commune (Dak Glong district), Quang Phu and Dak Nang commune (Krong No district), Dak Nong province, to determine the diversity of plant resources. The temporary transect survey and sample plot method were applied to assess the properties of forest resources as the foundation for conservation management and sustainable development of this valuable resource. This study demonstrates that the flora in Dak Nong has tremendous and vital value in terms of plant biodiversity. A total of 731 species, 425 genera, and 145 families of plants were recorded. The most diverse families are Fabaceae, Orchidaceae, Asteraceae, Rubiaceae, etc. The genera with dominant species numbers are *Ficus*, *Syzygium*, *Bulbophyllum*, *Cinnamomum*, *Crotalaria*, etc. Regarding the life-form spectrum, Phanerophytes (Ph) accounted for 85.50% of species of the whole flora; in terms of plant geography, up to 89.47% of species belonging to tropical elements in the study area. The flora has high use and conservation value, with 533 useful plant species and 74 plant species threatened nationally and internationally. These results indicate that merging this forest resource into Nam Nung Nature Reserve is required to more effectively manage, conserve and develop a valuable resource beyond its potential and value.

Keywords: conservation, Dak Nong, life form spectrum, phytogeographical, plant diversity.

1. INTRODUCTION

Plant diversity plays a pioneering role in the conservation of biodiversity in general. They play a crucial role in conserving land, water, agroecosystems, habitats for animals and other organisms, actively participating in climate regulation, providing direct value to humans from non-timber forest products, etc. Forest resources in Quang Son commune (Dak Glong district), and Quang Phu, Dak Nang communes (Krong No district) belong to the administrative boundary of Dak Nong province, adjacent to Nam Nung Nature Reserve. Therefore, forest resources have many similarities in ecosystem composition and direct and indirect values. However, there has not been any evaluation of these forest resources as a reliable scientific basis for proposals to manage and conserve resources effectively.

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The forest resources here have 02 significant ecosystems: the evergreen broad-leaved forest and the bamboo mixed timber forest. The natural evergreen broad-leaved forest ecosystem occupies a large area, accounting for over 90% of the entire flora area. However, has a smaller area compared to other Nature Reserve and National Parks of the Central Highlands. But it has a diverse and rich forest ecosystem with moist tropical evergreen closed forests that play a critical role in watershed protection, erosion control, water regulation for the Krong No river system, water storage for reservoirs, and dams for irrigation and hydroelectricity in Dak Nong province. Therefore, the conservation and development of forests here are vital tasks. This study aims to identify the characteristics of forest resources (1) the diversity of taxa levels, (2) the diversity of the life forms spectrum, (3) the diversity of

phytogeographical factors and (4) the potential value of plant resources.

2. RESEARCH METHODOLOGY

2.1. Study area

This study was conducted from November 2021 to December 2022 at Quang Son commune (Dak Glong district), Quang Phu, and Dak Nang commune (Krong No district), Dak Nong province (Figure 1). The study region had a total natural area of about 9000 ha. The terrain was diverse and rich, alternating with valleys; the average altitude was over 800m. The climate was a humid tropical plateau influenced by the

hot, dry southwest monsoon. The weather had two distinct seasons. The rainy season starts from April to November and concentrates 90% of the annual rainfall. At the same time, the dry season was from November to April, with little rain. The average temperature was about 21-22°C per year. The average annual rainfall was 2200 - 2400 mm. The average humidity of the air was 84% per year. The natural forest was the most significant natural resource in the region, with a coverage of 65%, making an essential contribution to local biodiversity conservation [1].

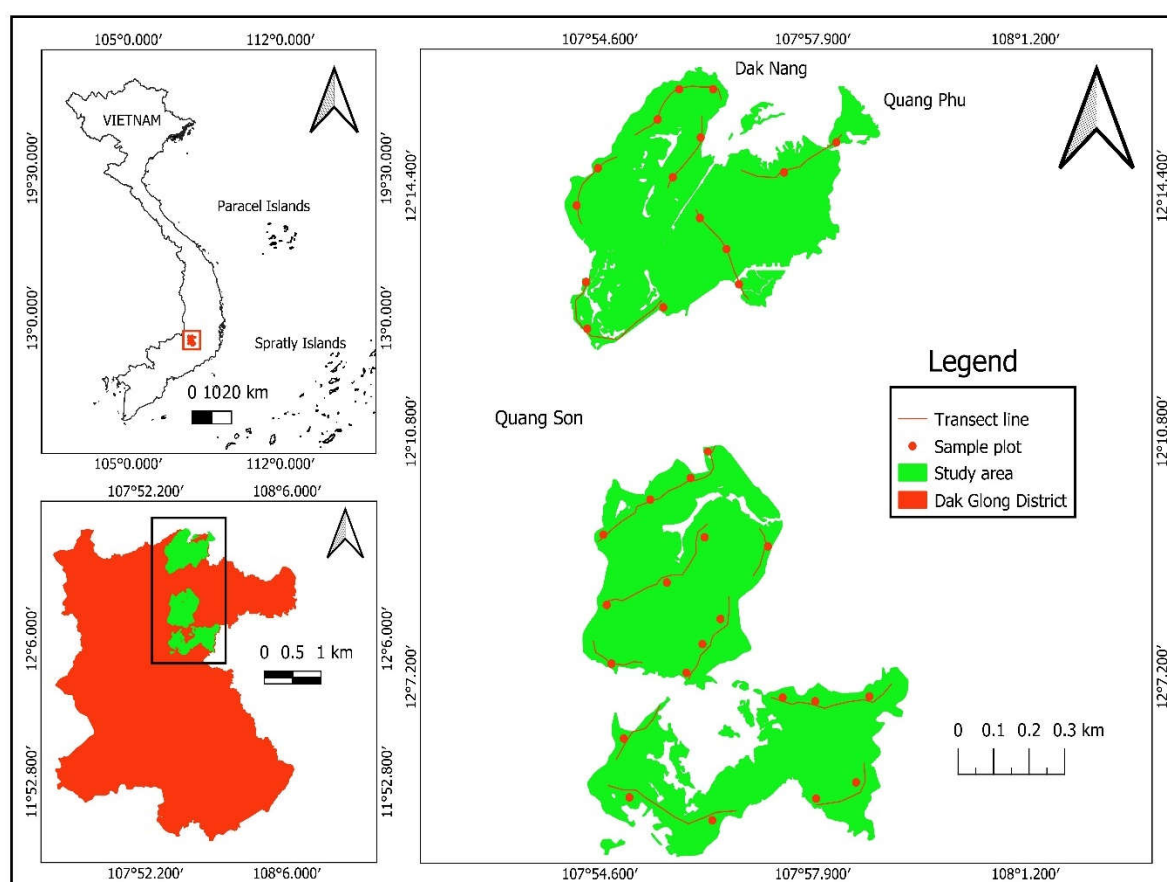


Figure 1. Map of the study area

2.2. Field investigation

Data were collected at 15 transect lines of the study area's typical elevation belts and forest status, including 1681, 1693, 1670, 1711, 1701, 1692, 1611, 1326, 1619, and 1620 subdivisions. The width of each transect line was 5 m, and the

length was 1.5-4.5 km. On the survey transects, 35 sample plots were established with an area of 500 m² (25 m x 20 m). Plant samples, photos, and recorded information about the plant species were collected in each plot.

2.3. Data analysis

Plant samples were collected and processed according to the document "Handbook of Biodiversity Research" [2]. Comparative morphological and expert methods were used to treat and identify plant samples. The documents used include An Illustrated Flora of Vietnam, volumes 1-3 [3]; Timber Resources in Vietnam [4]. The scientific name of the plant species was edited and updated by Plants of the World Online (2022) [5] and The World flora online (2022) [6]. The plant species list was arranged according to the taxonomy of Brummitt (1992) [7]. The conservation status of the plant species was determined based on the Vietnam Red Data Book (2007) [8], IUCN Red List 2022 (Updated 12/2022) [9], and Decree No.84 (2021) of the Vietnam Government [10]. The use value was determined based on the results of consultation with local people and forest rangers; and the results of searching documents: An Illustrated Flora of Vietnam, volumes 1-3 [3]; 1900 Useful

Plant Species of Vietnam [11]; Essential oil plant resources in Vietnam [12]; Vietnamese medicinal plants and herbs [13]; Dictionary Medicinal of Vietnam [14]. Useful plant species were divided into 6 groups: Medicinal; Food; Timber; Ornamental; Essential oil; Tannins, dyes; and other uses. The life-form spectrum of plant species was evaluated according to the criteria of Raunkiaer (1934) [15]. The phytogeographical factors were determined according to Pocs Tamas's method [16].

3. RESULTS AND DISCUSSION

3.1. Diversity of plant taxon

3.1.1. Diversity in species composition

A total of 731 plant species of 425 genera and 145 families belonging to 4 phyla of vascular plants were recorded, namely Lycopodiophyta, Polypodiophyta, Gymnospermae, and Angiospermae. The diversity of taxon is shown in Table 1.

Table 1. Diversity of taxon

Phyta	Family		Genera		Species	
	No.	%	No.	%	No.	%
Lycopodiophyta	2	1.38	3	0.71	5	0.68
Polypodiophyta	18	12.41	28	6.59	48	6.57
Gymnospermae	4	2.76	6	1.41	7	0.96
Angiospermae	121	83.45	388	91.29	671	91.79
<i>Dicotyledones</i>	101	69.66	329	77.41	572	78.25
<i>Monocotyledones</i>	20	13.79	59	13.88	99	13.54
Total	145	100	425	100	731	100

Table 01 indicated that four phyla represented the flora; most of the taxa were concentrated in Angiospermae with a total of 671 species, 388 genera, and 121 families, accounting for 91.79% of species, 91.29% of genera, and 83.45% of families of the flora, respectively. Dicotyledones accounted for the majority, with 572 species (78.25%). Polypodiophyta followed this with a relatively small number of species, with 48 species (6.57%), and the lowest was Lycopodiophyta, with five species (0.68%). In general, the whole flora in the study area has an average of 5.04 species per family. The genus diversity index

was 1.72, with an average of 1.72 species and 2.93 genera for each family.

Trang (2017) found 654 plant species of 132 families at Quang Truc Forest. While 881 plant species of 175 families were recorded at Nam Nung Nature Reserve, and 1406 plant species of 190 families were explored at Ta Dung National Park [17]. This research suggests that the diversity of species and families is higher than that of this study. Although the number of species and families is lower than in Ta Dung National Park, it still has significant biodiversity compared to Nam Nung Nature Reserve (Figure 2).

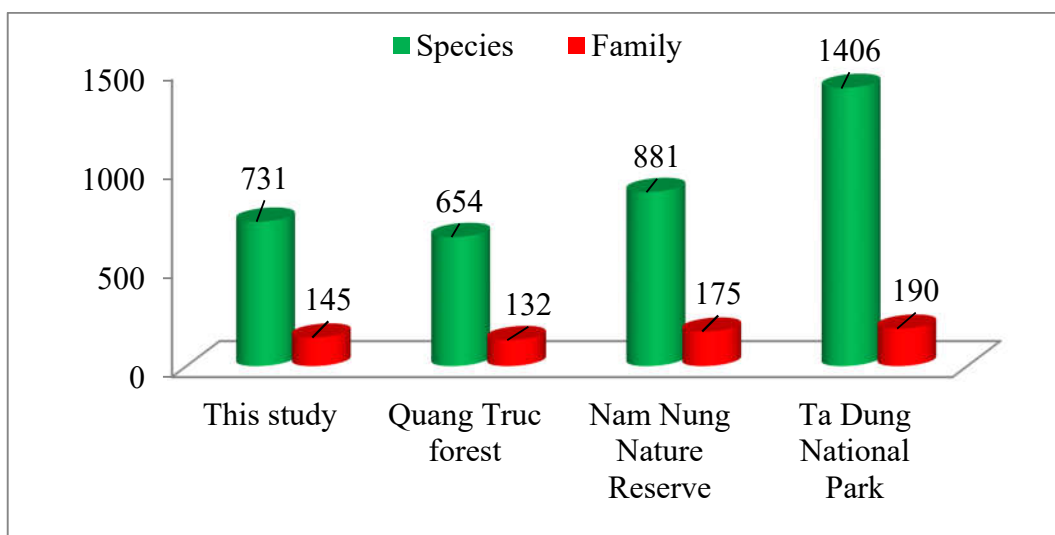


Figure 2. Comparison of this study to several regions in Dak Nong province

3.1.2. Diversity of genera and plant families

We have counted the ten most diverse families with 273 species, accounting for 6.90% of the total families and 37.35% of the total species. Families with various species compositions were represented by Fabaceae (50 species, 6.84%), Orchidaceae (45 species, 6.16%), Asteraceae (36 species, 4.92%), Rubiaceae (29 species, 3.97%), Moraceae, Malvaceae and Lamiaceae (21 species, 2.87%),

Apocynaceae (18 species, 2.46%), Phyllanthaceae (17 species, 2.33%), and Lauraceae (15 species, 2.05%). Most of the diverse families of the flora are species-rich families of the flora of Vietnam. In addition, the appearance of 2 subtropical plant families, Orchidaceae and Lauraceae, in the group of 10 species-rich families demonstrated the influence of topographic elevation on the species composition of the flora (Figure 3).

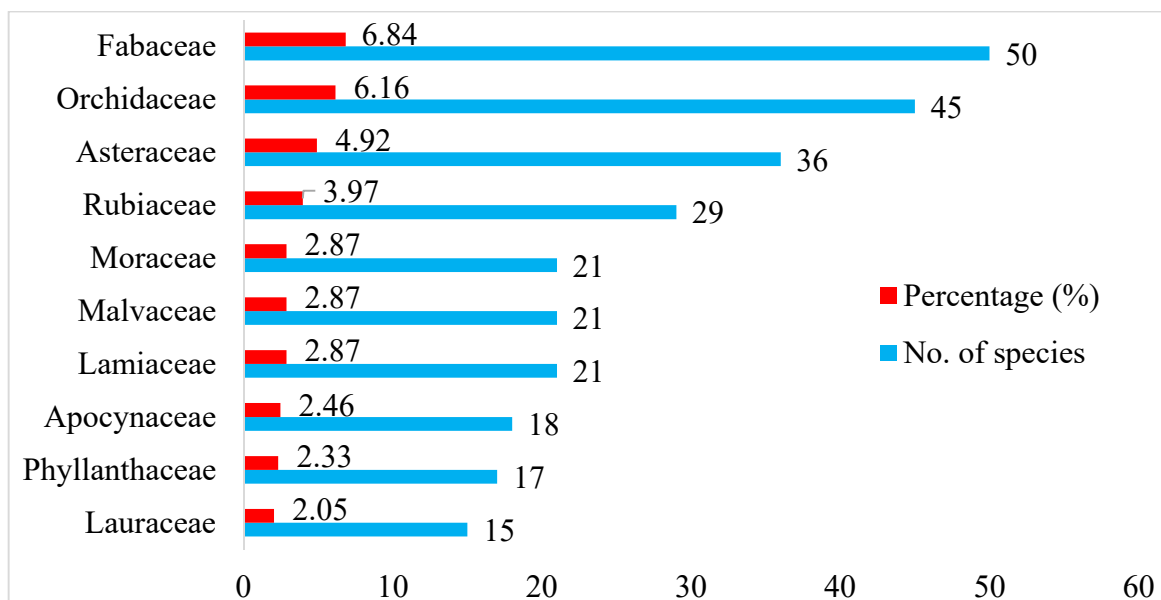


Figure 3. The ten most diverse families of the flora

We also recorded the ten most diverse genera with 73 species, representing 9.99% of the total species and 2.35% of the whole flora genera.

The *Ficus* genus had the most species with 14 species (1.92%), *Syzygium* (8 species, 1.09%), *Bulbophyllum*, *Cinnamomum* and *Crotalaria*

with seven species (7 species, 0.96%), *Senna*, *Elaeocarpus*, *Diospyros*, *Blumea*, and *Asplenium* (6 species, 0.82%). The existence of *Asplenium*, *Bulbophyllum*, *Blumea*, and *Crotalaria*, with primarily shade-loving, moist species, indicated that the area's flora was quite

wet. Other genera, such as *Cinnamomum*, *Elaeocarpus* belonging to the Lauraceae, and Elaeocarpaceae family, showed a subtropical nature because the area had many places with high terrain above 1000m (Figure 4).

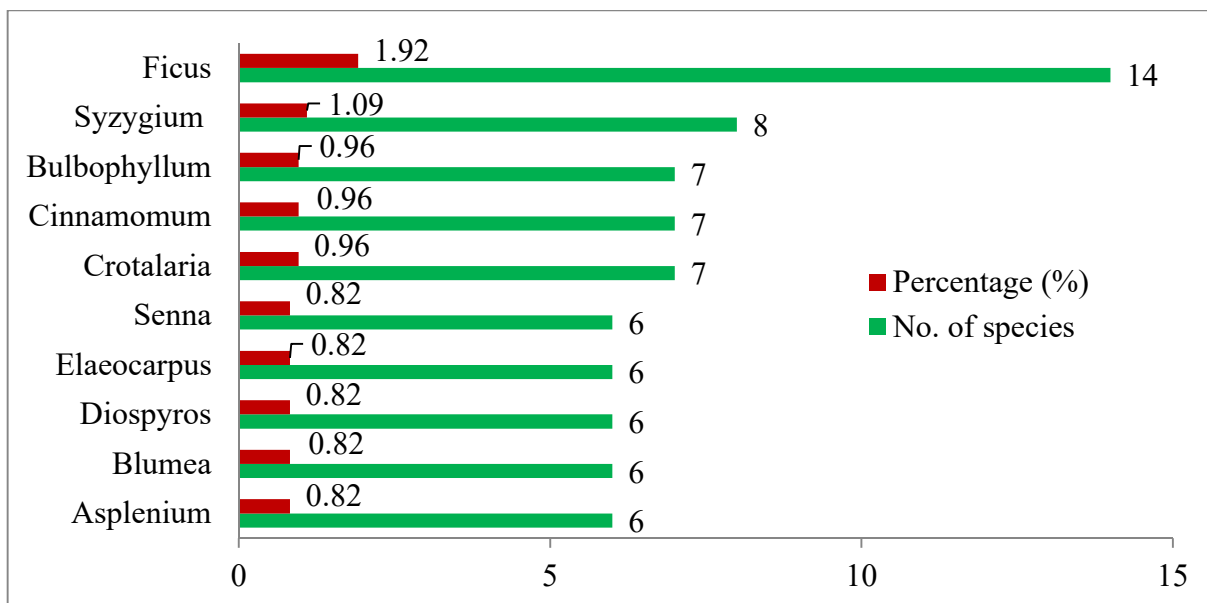


Figure 4. The ten most diverse genera of the flora

3.2. Diversity of life forms spectrum

and specific life forms are shown in Table 02.

The percentages of the life-form spectrum

Table 2. The life-form spectrum of the flora

No.	Life-form spectrum	Abbreviation	No. of species	%
1	Phanerophytes	Ph	625	85.5
1.1	Megaphanerophytes	Mg	49	6.7
1.2	Mesophanerophytes	Me	136	18.6
1.3	Microphanerophytes	Mi	99	13.54
1.4	Nanophanerophytes	Na	114	15.6
1.5	Lianas phanerophytes	Lp	79	10.81
1.6	Epiphytes phanerophytes	Ep	59	8.07
1.7	Herb phanerophytes	Hp	83	11.35
1.8	Parasit-hemiparasit phanerophytes	Pp	4	0.55
1.9	Succelet phanerophytes	Suc	2	0.27
2	Chamaephytes	Ch	21	2.87
3	Hemicryptophytes	Hm	12	1.64
4	Cryptophytes	Cr	21	2.87
5	Therophytes	Th	52	7.11
Total			731	100

Phanerophytes (Ph) account for the highest proportion, with 85.50% of the whole flora. Mesophanerophytes (Me) accounted for 18.60%. The remaining groups accounted for a low proportion, from 1.64% in Hemicyptophytes (Hm) to 7.11% in Therophytes (Th). The life-form spectrum of

the flora has been established as follows: SB = 85.50%Ph + 2.87%Ch + 1.64%Hm + 2.87%Cr + 7.11%Th.

3.3. Diversity of phytogeographical factors

Phytogeographic factors of the flora are summarised in Table 3.

Table 3. Phytogeographical factors of the flora

No.	Element	Abbreviation	No. of Species	%
1	World	1	7	0.96
2	Tropical		654	89.47
2.1	Intertropical		34	4.65
2.2.1	<i>Intertropical Africa, America, Asia, Australia</i>	2	27	3.69
2.2.2	<i>Intertropical Asia, Australia, Africa, and America</i>	2.1	4	0.55
2.2.3	<i>Intertropical Asia, Africa, and America</i>	2.2	1	0.14
2.2.4	<i>Intertropical Asia, America</i>	2.3	2	0.27
2.2	Ancient tropical elements		61	8.34
2.2.1	<i>Ancient tropical (Asia, Africa, Australia)</i>	3	8	1.09
2.2.2	<i>Tropical Asia and Australia</i>	3.1	49	6.70
2.2.3	<i>Tropical Asia and Africa</i>	3.2	4	0.55
2.3	Tropical Asia		559	76.47
2.3.1	<i>Asian tropical (Indo-Malesian)</i>	4	229	31.33
2.3.2	<i>Indochina - Malesia</i>	4.1	53	7.25
2.3.3	<i>Indochina - India = Tropical Asian continent</i>	4.2	104	14.23
2.3.4	<i>Indochina - Himalaya = Continent of Southeast Asia</i>	4.3	49	6.70
2.3.5	<i>Indochina - South China</i>	4.4	69	9.44
2.3.6	<i>Indochina</i>	4.5	55	7.52
3	Temperate		34	4.65
3.1	<i>Northern temperate</i>	5	8	1.09
3.2	<i>Temperate Mediterranean - Europe - Asia</i>	5.3	5	0.68
3.3	<i>East Asia</i>	5.4	21	2.87
4	Endemic		35	4.79
4.1	<i>Vietnam's endemic factor</i>	6	19	2.60
4.2	<i>Near endemic</i>	6.1	12	1.64
4.3	<i>Endemic to the North (Northwest)</i>	6.2	2	0.27
4.4	<i>Endemic to the Central Highlands</i>	6.3	2	0.27
5	Undefined		1	0.14
	Total		731	100

The flora of this study exhibits typical tropical flora characteristics because 89.47% of the species belong to tropical elements, and only 4.65% belong to the temperate. Most species belong to tropical Asia, with 76.47% tropical elements. Endemic accounts for a relatively low proportion (4.79%), considerably lower than the general endemic rate of the flora of Vietnam (11.49%) [18].

3.4. Diversity the value of plant resources

3.4.1. Diversity of useful plant species

Among 731 species/subspecies recorded, 533 species (72.91% of total species found) could be used in 7 groups: medicinal plants; food; essential oils; tannins, dyes; wood; ornamental plants; other uses. Which medicinal plants have the highest number of species (534 species, 73.05%), followed by food (172 species, 21.48%), timber (131 species, 17.92%), ornamental plants (84 turns of species, 10.40%), other use (33 species, 4.51%) the lowest was Tannin, dye (15 species, 1.78%) (Figure 5).

Medicinal plants: Medicinal plants were concentrated in Lamiaceae, Menispermaceae, Vitaceae, Rubiaceae, Araliaceae, Asteraceae,

Phyllanthaceae, Fabaceae, Amaranthaceae, Zingiberaceae, Rutaceae. Several plant species were used by local people such as *Persicaria chinensis*, *Polygala paniculata*, *Passiflora edulis*, *Coscinium fenestratum*, *Fibraurea tinctoria*, *Stephania rotunda*, *Cibotium barometz*, *Achyranthes aspera*, *Euodia leptota*, *Melicope accedens*, *Kadsura coccinea*, *Crotalaria spp.*, *Lasia spinosa*, *Epipremnum giganteum*, *Disporopsis longifolia*, and *Codonopsis javanica*, etc.

Plant species for food: *Gnetum gnemon* var. *griffithii*, *Diplazium esculentum*, *Amaranthus lividus*, *Schefflera heptaphylla*, *Trevasia palmata*, *Crassocephalum crepidioides*, *Erechtites valerianifolia*, *Pluchea indica*, *Begonia aptera*, *Dillenia ovata*, *Dialium cochinchinensis*, *Lithocarpus fenestratus*, *Castanopsis pyriformis*, *Premna odorata*, *Walsura robusta*, *Syzygium cumini*, *Phyllanthus emblica*, *Passiflora foetida*, *Antidesma ghaesembilla*, *Bischofia javanica*, *Maesa indica*, *Solanum torvum*, *Barringtonia marostachya*, *Rubus alcaefolius*, *Altingia siamensis*, etc

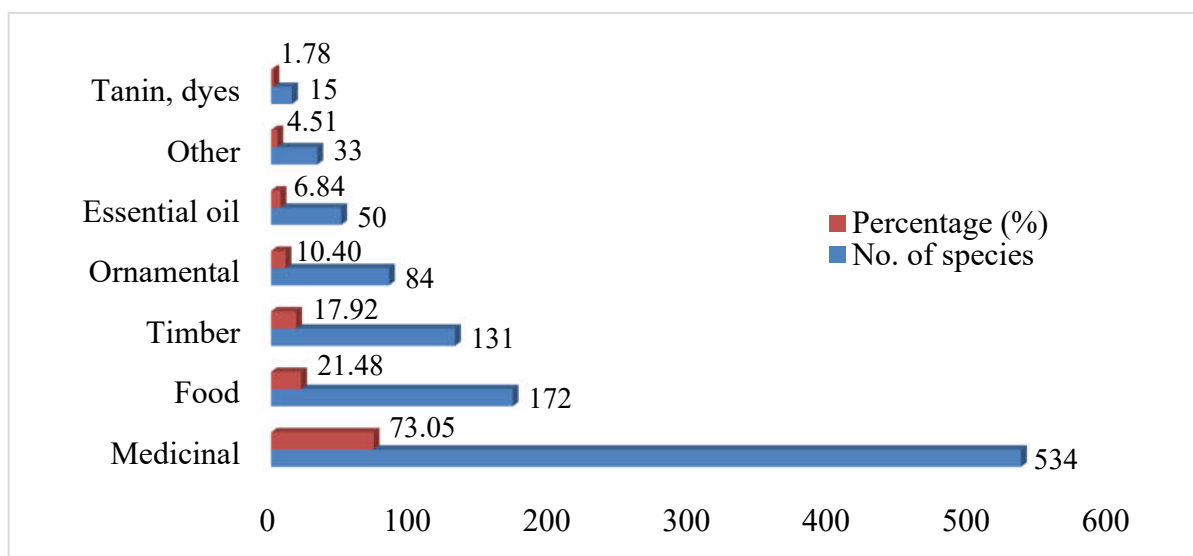


Figure 5. The useful group plant

Plant species for timber: Represented by Lauraceae, Myrtaceae, Fagaceae, Dipterocarpaceae, *Elaeocarpus spp.*, *Diospyros spp.*, *Pinus kesyia*, *Dacrycarpus imbricatus*,

Nageia fleuryi, *Podocarpus neriifolius*, *Sindora siamensis*, *Senna siamea*, *Azelia xylocarpa*, *Gironniera subaequalis*, *Schima wallichii*, etc.

Plant species for ornamental: *Ochna*

integerrima, *Begonia spp.*, *Impatiens spp.*, *Dischidia spp.*, *Alstonia scholaris*, *Pseuderanthemum crenulatum*, *Asplenium nidus*, *Hoya spp.*, *Rhododendron fleuryi*, *Clerodendrum spp.*, etc.

Plant species for essential oil, sap: Rutaceae, Zingiberaceae, Lauraceae, Magnoliaceae. Plant species that represented essential oils, such as *Zingiber spp.*, *Kaempferia spp.*, *Alpinia comchigera*, *Amomum biflorum*, *Polygala spp.*, *Cinnamomum spp.*, *Litsea spp.*, *Magnolia braianensis*, *Euodia spp.*, *Zanthoxylum spp.*, *Acronychia pedunculata*, *Clausena excavata*, *Murraya alata*, *Paramignya monophylla*, *Croton delpyi*, *Illicium griffithii* var. *cambodianum*, *Cratoxylum spp.*, *Garcinia spp.*, etc.

Plant species for dyes and tannins: *Bixa orellana*, *Oroxylum indicum*, *Clitoria ternatea*, *Clitoria mariana*, *Fibraurea tinctoria*,

Archidendron clypearia, *Triadica cochinchinensis*, *Dicliptera chinensis*, *Rhus chinensis*, *Phyllanthus reticulatus*, *Syzygium spp.*, *Camelia spp.*, *Schima*.

Plant species for other uses (leaves, fibers, construction, crafts, etc.): *Bambusa spp.*, *Trema spp.*, *Broussonetia papyrifera*, *Calamus spp.*, *Gonocaryum lobbianum*, *Tetracera spp.*, *Ancistrocladus spp.*

3.4.2. Diversity of conservation value

The flora is quite diverse in species composition and conservation value. We have made statistics and recorded 74 plant species belonging to 19 families, accounting for 10.12% of total species and 13.10% of total families. Of these, 26 species are listed in the Vietnam Red Data Book (2007), 15 species in the IUCN Red List (2022) (accessed 12/2022) (Details are in Table 4), and 57 species in Decree No. 84 (2021).

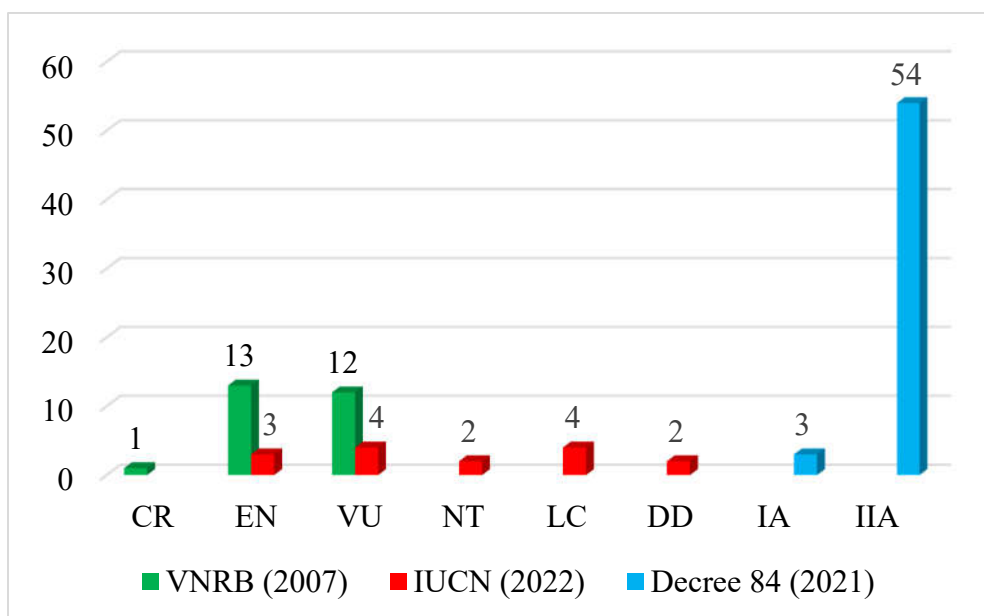


Figure 6. Statistics on species composition of conservation value

Note: VRDB - Vietnam Red Data Book (2007); IUCN - Global conservation status (2022); CR - Critically Endangered; EN - Endangered; VU - Vulnerable; NT - Near threatened; LC - Least Concern; DD - Data deficient; Decree 84 (2021): Decree No. 84 in 2021 of the Government of Vietnam.

Comparison with some flora regions in Dak Nong province demonstrates the composition of threatened species in this study is lower than in

Ta Dung National Park. However, it is more than Quang Truc and similar to Nam Nung Nature Reserve [17] (Figure 7).

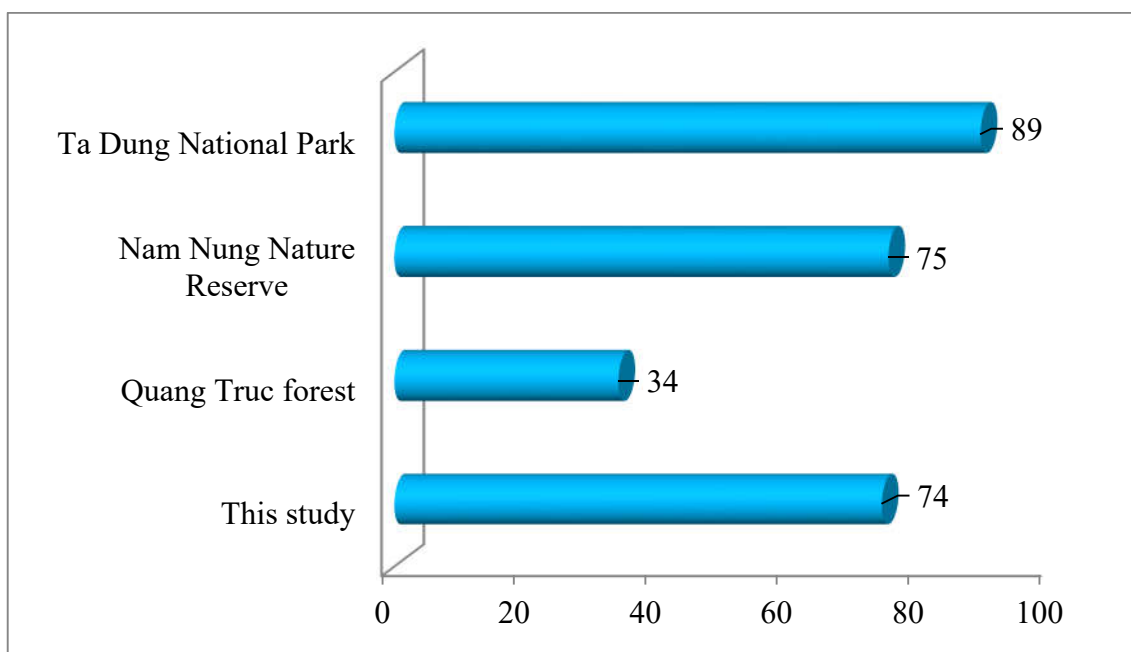


Figure 7. Comparison of threatened species in some regions in Dak Nong province

4. CONCLUSION

Flora of Dak Nong province is diverse in taxa, life forms spectrum, phytogeographical factors, and value of plant forest resources. We have recorded 731 species, 425 genera, and 145 families belonging to 4 phyla of vascular plants. The life-form spectrum of flora was determined as SB = 85.50%Ph + 2.87%Ch + 1.64%Hm + 2.87%Cr + 7.11%Th, showing very evidently the tropical nature of the flora. In addition, the flora is also very diverse in phytogeographical factors, in which the tropical element accounts for the highest, with 89.47% of the species in the whole system. Moreover, the flora has high value with 533 useful plant species belonging to medicinal plants; food; essential oils; tannins, dyes; wood; ornamental plants; and other uses. On the other hand, this place also has a high conservation value, with 74 species threatened at different levels nationally and internationally. We recommend merging with Nam Nung Nature Reserve to manage better and protect this place's biodiversity values.

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ĐA DẠNG THỰC VẬT TẠI TỈNH ĐẮK NÔNG, VIỆT NAM: NGHIÊN CỨU ĐIỂM TẠI HUYỆN ĐẮK GLONG VÀ KRÔNG NÔ

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TÓM TẮT

Nghiên cứu này được thực hiện tại xã Quảng Sơn (huyện Đắk Glong), Quảng Phú và xã Đắk Nang (huyện Krông Nô), tỉnh Đắk Nông nhằm xác định đa dạng tài nguyên thực vật. Phương pháp khảo sát tuyến tạm thời và thiết lập ô mẫu được áp dụng để đánh giá các đặc điểm của tài nguyên rừng làm cơ sở cho công tác quản lý, bảo tồn và phát triển bền vững nguồn tài nguyên rừng. Nghiên cứu này chứng minh rằng hệ thực vật ở Đắk Nông có giá trị to lớn và quan trọng về mặt đa dạng sinh học thực vật. Tổng cộng có 731 loài, 425 chi và 145 họ thực vật đã được ghi nhận. Các họ đa dạng nhất là Fabaceae, Orchidaceae, Asteraceae, Rubiaceae, vv. Các chi có số loài chiếm ưu thế là *Ficus*, *Syzygium*, *Bulbophyllum*, *Cinnamomum*, *Crotalaria*, vv. Về phổ dạng sống, nhóm cây chồi trên (Phanerophytes) chiếm 85,50% các loài của hệ thực vật; về yếu tố địa lý thực vật, có tới 89,47% số loài thuộc yếu tố nhiệt đới tại khu vực nghiên cứu. Hệ thực vật có giá trị sử dụng và bảo tồn cao, với 533 loài thực vật có ích, 74 loài thực vật bị đe dọa trong nước và quốc tế. Kết quả này cho thấy cần phải sáp nhập tài nguyên rừng này vào Khu bảo tồn thiên nhiên Nam Nung để quản lý, bảo tồn và phát triển hiệu quả nguồn tài nguyên quý giá, tương xứng với tiềm năng và giá trị của nó.

Từ khóa: bảo tồn, đa dạng thực vật, Đắk Nông, địa lý thực vật, phổ dạng sống.

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