# Investigation and Analysis of Plant Species Richness at Danzhou Campus of Hainan University

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**Abstract.** Campus vegetation is an important part of the campus environment, and the construction of an ecological campus is an essential component of campus development. A field survey and diversity analysis of woody plants and herbaceous plants of Danzhou Campus, Hainan University was conducted. The results showed that there are 67 species of woody plants on campus, belonging to 34 families and 58 genera, with Shannon-Weiner diversity indices ranging from 1.5596 to 3.0824, the Simpson's indices ranging from 0.7031 to 0.9442, and the Pielou's evenness indices ranging from 0.2960 to 0.4807. This paper aims to provide feasible references and suggestions for the plant configuration of Danzhou campus of Hainan University.

**Keywords:** Hainan University; Danzhou Campus; Campus plants; Species richness.

## 1. Introduction

Campus environment construction is an important part of university construction, and plant communities play a vital role in the campus ecosystem[1-4]. At present, universities are paying more and more attention to campus plant configuration, so the investigation of plant species diversity on campus is gradually increasing. The Danzhou campus of Hainan University is rich in plant resources. Through the investigation of plant species, quantity and distribution on campus, we analyze plant greening, community ecological structure and ornamental values to provide feasible references for campus plant configuration[5-8].

## 2. Overview of the Study Site

Danzhou city is located in the northwest of Hainan Island, the eastern shore of Beibu Gulf, with the geographical coordinates of 19 ° 11′ ~ 19 ° 52′ north latitude, and 108 ° 56′ ~ 109 ° 46′ east longitude. Danzhou city is on the southern edge of the East Asian monsoon climate, a tropical monsoon climate. Due to the island's central rise of the Wuzhi Mountains, in the leeward side but also near the Beibu Gulf, there is a unique microclimate. It also receives solar radiation energy of 110 to 130 kcal per square centimeter throughout the year, and summer solar radiation is the most, accounting for 31% of the annual radiation. Spring radiation is the second, accounting for 28%, autumn radiation accounts for 23%, and winter radiation is the least, accounting for 18%. The annual rainfall in all areas ranges from 900 to 2200 mm, with an annual average of 1815 mm, reaching more than 1500 mm in most areas. The average annual wind speed in all areas is 1 to 4 m/s. The climate is suitable for the cultivation of many kinds of plants, with abundant rainfall and excellent sunshine conditions [9-11].

## 3. Research Methodology

For the actual situation of Danzhou campus of Hainan University, the campus was divided into four areas: student dormitory area, teaching building area, agricultural and forestry avenue area, and sports field area. By field survey and data recording, the species diversity index and species evenness index of each area were calculated. The Shannon-Wiener index, Simpson's index, and Pielou's evenness index were used to measure species diversity and species richness in this survey [12-16].

### 3.1 Shannon-Wiener Index

The Shannon-Weiner index is used to describe the disorder and uncertainty in the occurrence of individuals of a species. The higher the uncertainty is, the higher the diversity will be. It is calculated by the formula.

$$H=-\sum P_i \times \ln P_i$$

where, Pi - the proportion of individuals belonging to species i among all individuals
H - species diversity index

### 3.2 Simpson's Index

Simpson's diversity index = probability that two randomly sampled individuals belong to different species

=1－Probability that two individuals sampled at random belong to the same species

Suppose the number of individuals of species i is Pi of the total individuals in the community, then the joint probability of taking two individuals of species i at random is Pi2. If we combine the probabilities of all species in the community, we can obtain the Simpson's index D, which is

$D=1-\sum Pi2$

Since the sampled aggregate is an infinite aggregate, the true value of Pi is unknown, so its maximum necessary estimator is:

$Pi = Ni / N$

that is,

$$1-\sum Pi2 = 1-\sum (Ni/N)2$$

Thus, the Simpson's index is:

$$D=1-\sum Pi2 = 1-\sum (Ni/N)2$$

where, Ni - the number of individuals of species i
N - the number of individuals of all species in the community

### 3.3 **Pielou's Evenness Index**

$$JSW=-\sum (Pi \times \ln Pi)/\ln s$$

where, $Pi = Ni / N$

s - the number of species surveyed in the area
Ni - the number of individuals of the ith population
N - sum of multi-degree indicators for each species in the survey area

## 4. Analysis of Results

### 4.1 Plant Species Statistics by Area

There are 45 species of woody plant types belonging to 26 families and 37 genera in the student dormitory area; 43 species of woody plant types belonging to 23 families and 36 genera in the teaching building area; 8 species of woody plant types belonging to 7 families and 8 genera in the agriculture and forestry avenue area; and 8 species of woody plant types belonging to 6 families and 8 genera in the sports field area [17-20].

**Table 1.** Woody Plants in Student Dormitory Area

| Family | Genus | Species | Latin | Total |
|---|---|---|---|---|
| Palmaceae | Livistona | Livistona chinensis | *Livistona chinensis* | 16 |
| | Elaeis Jacq | Oil Palm | *Elaeis guineensis* | 36 |
| | Cocos | coconut palm | *Cocos nucifera* | 37 |
| | Roystonea | Roystonea regia | *Roystonea regia* | 105 |
| Papilionaceae | Dalbergia | Dalbergia odorifera | *Dalbergia odorifera* | 31 |
| | Narra | Pterocarpus indicus | *Pterocarpus indicus* | 81 |
| | Narra | Andaman padauk | *Pterocarpus indicus* | 55 |
| Sapotaceae | Pouteria | Pouteria campechiana (Kunth) Baehni | *Pouteria campechiana* | 2 |
| | Mimusops L. | Mimusops elengi | *Mimusops elengi* | 37 |
| Mimosoideae | Acacia Mill. | Acacia farnesiana | *Acacia farnesiana* | 4 |
| | Samanea | Samanea saman | *Samanea saman* | 1 |
| Moraceae | Artocarpus Forst | Artocarpus heterophyllus | *Artocarpus heterophyllus* | 8 |
| | Ficus | Ficus microcarpa | *Ficus microcarpa* | 3 |
| | Ficus | Ficus altissima | *Ficus altissima* | 12 |
| | Ficus | Ficus carica | *Ficus carica* | 11 |
| | Ficus | Ficus benjamina | *Ficus benjamina* | 2 |
| | Ficus | Ficus virens | *Ficus virens* | 4 |
| Sapindaceae | Litchi Sonn | Litchi chinensis | *Litchi chinensis* | 11 |
| Meliaceae | Swietenia Jacq. | Swietenia macrophylla King | *Swietenia macrophylla* | 10 |
| | Melia L. | Melia azedarac | *Melia azedarach* | 39 |
| | Khaya | Khaya senegalensis | *Khaya senegalensis* | 6 |
| Caesalpiniaceae | Delonix | Delonix regia | *Delonix regia* | 11 |
| | Bauhinia | Bauhinia purpurea | *Bauhinia purpurea* | 15 |
| Caricaceae | Carica Linn. | Carica papaya | *Carica papaya* | 3 |
| Rosaceae | Persica Mill | Amygdalus davidiana | *Amygdalus davidiana* | 1 |
| Lythraceae | Lagerstroemia | Lagerstroemia speciosa | *Lagerstroemia speciosa* | 4 |
| | Lagerstroemia | Lagerstroemia floribunda | *Lagerstroemia floribunda* | 4 |
| Combretaceae | Terminalia | Terminalia catappa | *Terminalia catappa* | 3 |
| | Terminalia | Terminalia neotaliala | *Terminalia neotaliala* | 8 |
| Apocynaceae | Alstonia | Alstonia scholaris | *Alstonia scholaris* | 4 |
| Lauraceae | Cinnamomum L. | Cinnamomum camphora | *Cinnamomum camphora* | 7 |
| Magnoliaceae | Michelia | Champac | *Cephalantheropsis gracilis* | 1 |
| | Michelia | Michelia alba | *Michelia alba* | 3 |
| Sterculiaceae | Sterculia | Sterculia lanceolata | *Sterculia lanceolata* | 5 |
| Dipterocarpaceae | Hopea Roxb. | Hopea hainanensis | *Hopea hainanensis* | 13 |
| Malvaceae | Hibiscus | Hibiscus rosa-sinensis | *Hibiscus rosa-sinensis* | 1 |
| Rutaceae | Clausena | Clausena lansium | *Clausena lansium* | 1 |
| Anacardiaceae | Mangifera | Mangifera indica | *Mangifera indica* | 1 |
| | Dracontomelon | Dracontomelon duperreanum | *Dracontomelon duperreanum* | 1 |
| Myrtaceae | Syzygium | Syzygium hainanense | *Syzygium hainanense* | 1 |
| Hippocastanaceae | Aesculus L. | Aesculus chinensis | *Aesculus chinensis* | 1 |
| Bignoniaceae | Handroanthus | Handroanthus chrysanthus | *Handroanthus chrysanthus* | 2 |
| Annonaceae | Polyalthia | Polyalthia longifolia | *Polyalthia longifolia* | 5 |
| Dilleniaceae | Dillenia | Dillenia indica | *Dillenia indica* | 1 |
| Bombacaceae | Bombax Linn. | Bombax ceiba | *Bombax ceiba* | 2 |

**Table 2.** Woody Plants in the Teaching Building Area

| Family | Genus | Species | Latin | Total |
|---|---|---|---|---|
| Sapindaceae | Litchi Sonn | Litchi chinensis | *Litchi chinensis* | 5 |
| Apocynaceae | Plumeria L. | Plumeria rubra | *Plumeria rubra* | 12 |
| | Winchia | Winchia calophylla | *Winchia calophylla* | 1 |
| | Alstonia | Alstonia scholaris | *Alstonia scholaris* | 24 |
| Magnoliaceae | Michelia | Michelia alba | *Michelia alba* | 7 |
| | Michelia | Cephalantheropsis gracilis | *Cephalantheropsis gracilis* | 2 |
| Caesalpiniaceae | Delonix | Delonix regia | *Delonix regia* | 22 |
| | Bauhinia | Bauhinia purpurea | *Bauhinia purpurea* | 18 |
| Lythraceae | Lagerstroemia | Lagerstroemia speciosa | *Lagerstroemia speciosa* | 12 |
| Araucariaceae | Araucaria | Araucaria cunninghamii | *Araucaria cunninghamii* | 19 |
| Moraceae | Ficus | Ficus virens | *Ficus virens* | 6 |
| | Ficus | Ficus altissima | *Ficus altissima* | 23 |
| | Ficus | Ficus benjamina | *Ficus benjamina* | 3 |
| | Ficus | Ficus microcarpa | *Ficus microcarpa* | 2 |
| | Artocarpus Forst | Artocarpus heterophyllus | *Artocarpus heterophyllus* | 13 |
| Podocarpaceae | Podocarpus | Podocarpus nagi | *Podocarpus nagi* | 14 |
| Palmaceae | Cocos | Cocos nucifera | *Cocos nucifera* | 104 |
| | Clausena | Roystonea regia | *Roystonea regia* | 188 |
| | Archontophoenix | Archontophoenix alexandrae | *Archontophoenix alexandrae* | 4 |
| | Elaeis Jacq | Elaeis guineensis | *Elaeis guineensis* | 9 |
| | Areca L | Areca catechu | *Areca catechu* | 34 |
| Papilionaceae | Pterobotherus | Pterocarpus indicus | *Pterocarpus indicus* | 10 |
| | Pterobotherus | Pterocarpus santalinus | *Pterocarpus indicus* | 5 |
| Bignoniaceae | Spathodea | Spathodea campanulata | *Spathodea campanulata* | 2 |
| | Kigelia | Kigelia africana | *Kigelia africana* | 4 |
| Lauraceae | Litsea | Litsea glutinosa | *Litsea glutinosa* | 1 |
| | Melia L. | Cinnamomum camphora | *Cinnamomum camphora* | 20 |
| | Persea | Butyrospermum parkii | *Butyrospermum parkii* | 1 |
| Combretaceae | Terminalia | Terminalia neotaliala | *Terminalia neotaliala* | 1 |
| | Terminalia | Terminalia catappa | *Terminalia catappa* | 1 |
| Sapotaceae | Mimusops L. | Mimusops elengi | *Mimusops elengi* | 1 |
| Styracaceae | Styrax | Styrax suberifolius | *Styrax suberifolius* | 9 |
| Cupressaceae | Juniperus | Juniperus chinensis | *Juniperus chinensis* | 1 |
| Oleaceae | Osmanthus | Osmanthus Flower | *Osmanthus fragrans* | 2 |
| | Fraxinus | Fraxinus chinensis | *Fraxinus chinensis* | 3 |
| Juglandaceae | Pterocarya | Pterocarya stenoptera | *Pterocarya stenoptera* | 1 |
| | Cyclocarya | Cyclocarya paliurus | *Cyclocarya paliurus* | 1 |
| Anacardiaceae | Pistacia | Pistacia sinensis | *Pistacia chinensis* | 5 |
| Bombacaceae | Bombax Linn. | Bombax ceiba | *Bombax ceiba* | 20 |
| | Bombax Linn. | Ceiba pentandra | *Ceiba pentandra* | 3 |
| Meliaceae | Khaya | Khaya senegalensis | *Khaya senegalensis* | 13 |
| Rubiaceae | Hamelia | Hamelia patins | *Hamelia patins* | 1 |
| Mimosoideae | Samanea | Samanea saman | *Samanea saman* | 2 |

**Table 3.** Woody Plants in the Agriculture and Forestry Avenue Area

| Family | Genus | Species | Latin | Total |
|---|---|---|---|---|
| Meliaceae | Swietenia Jacq. | Swietenia macrophylla King | *Swietenia macrophylla* | 133 |
| | Khaya | Khaya senegalensis | *Khaya senegalensis* | 11 |
| Caesalpiniaceae | Delonix | Delonix regia | *Delonix regia* | 2 |
| Sapindaceae | Litchi Sonn | Litchi chinensis | *Litchi chinensis* | 1 |
| Flacourtiaceae | Hydnocarpus Gaertn | Hydnocarpus anthelminthica | *Hydnocarpus anthelminthica* | 6 |
| Papilionaceae | Pterobotherus | Pterocarpus indicus | *Pterocarpus indicus* | 9 |
| Myrtaceae | Eucalyptus | Eucalyptus citriodora | *Eucalyptus citriodora* | 3 |
| Palmaceae | Clausena | Roystonea regia | *Roystonea regia* | 34 |

**Table 4.** Woody Plants in the Sports Field Area

| Family | Genus | Species | Latin | Total |
|---|---|---|---|---|
| Meliaceae | Khaya | Khaya senegalensis | *Khaya senegalensis* | 50 |
| | Swietenia Jacq. | Swietenia macrophylla King | *Swietenia macrophylla* | 36 |
| Papilionaceae | Pterobotherus | Pterocarpus indicus | *Pterocarpus indicus* | 11 |
| Podocarpaceae | Podocarpus | Podocarpus nagi | *Podocarpus nagi* | 8 |
| Palmaceae | Archontophoenix | Archontophoenix alexandrae | *Archontophoenix alexandrae* | 9 |
| | Clausena | Roystonearegia | *Roystonea regia* | 62 |
| Caesalpiniaceae | Delonix | Delonix regia | *Delonix regia* | 3 |
| Apocynaceae | Winchia | Winchia calophylla | *Winchia calophylla* | 12 |

### 4.2 Plant Diversity Analysis

#### 4.2.1 Shannon-Wiener Index

The Shannon-Wiener index fluctuated between 1.5596 and 3.0824 for the four areas on campus (Figure 1). Among them, the student dormitory area had the highest plant diversity index of 3.0824, and the sports field area had the lowest plant diversity index of 1.5596.

Depending on the function undertaken by each area, there must be differences in the types of plant cultivation. In general, the number of palmaceae and meliaceae plants on campus is significantly higher than other plants, and the large canopies of such plants play a particularly important role in summer when they provide significant shade. In contrast to the sports field area, which has the lowest Shannon-Wiener index, the most obvious indoor sports arena, for example, is empty under tall trees and has a significantly lower plant hierarchy than other areas, suggesting that some flowering shrubs should be cultivated appropriately to increase land efficiency. Although the plant diversity index is the highest in the student dormitory area, it is recommended that the number and types of tall trees in the lawn area in front of and behind the cafeteria are low. It is recommended that tropical fruit trees, such as clausena wampi and lychee, be planted to increase the ornamental value and practicality. The Shannon-Wiener index is only 1.5671, but the trees are old and the tree species are reasonable, forming a reasonable plant hierarchy, and the foliage falls in March and April every year, forming a very ornamental foliage landscape. The teaching area index reaches 2.9551, second only to the student dormitory area, and the cultivated tree species are mostly palmaceae and moraceae plants, creating a good learning environment [21-24].

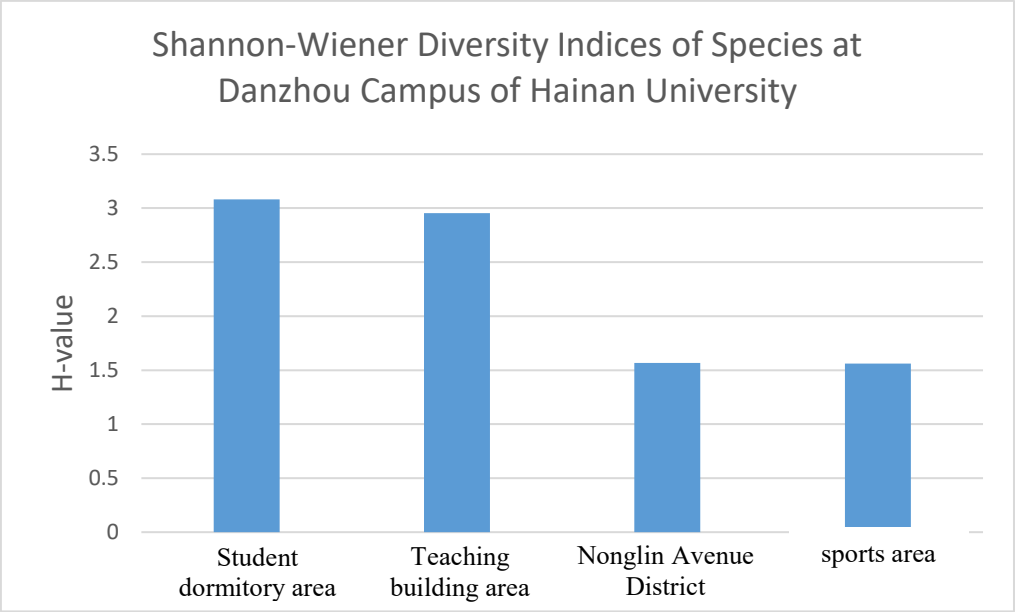


**Figure 1.** Shannon-Wiener Diversity Indices of Species at Danzhou Campus of Hainan University

### 4.2.2 Simpson's Index

The Simpson's indices of the four main areas of the Danzhou campus of Hainan University fluctuated between 0.7031 and 0.9442 (Figure 2). The difference in Simpson's index between "the student dormitory area and the teaching building area", and "the agricultural and forestry avenue area and the sports field area" was large. The main reason for this is that the main species of trees in the agricultural and forestry avenue area and the sports field area are mainly palmaceae and meliaceae species, and there are fewer other species of trees, so other suitable species can be planted appropriately to improve the diversity [21-24].

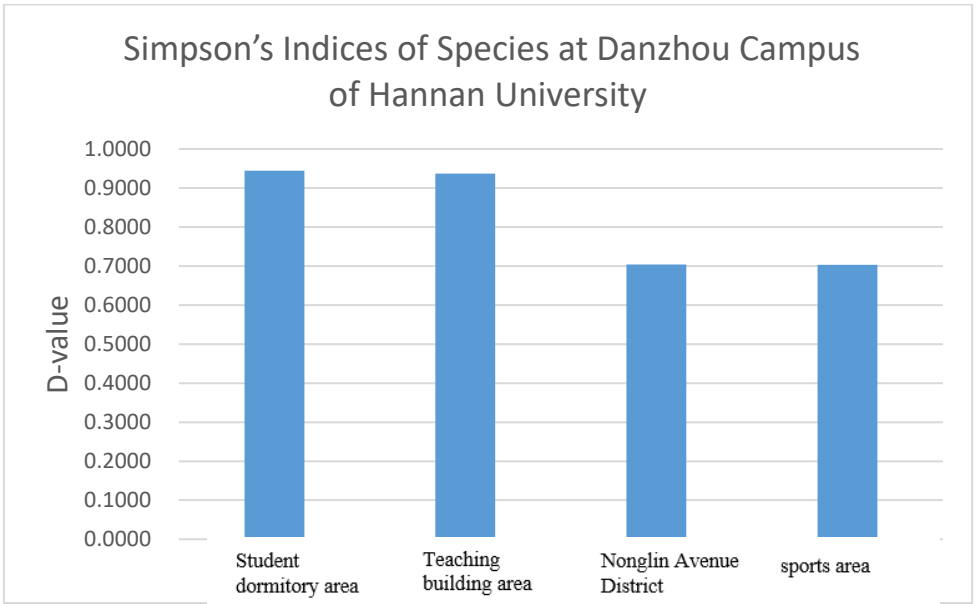


**Figure 2.** Simpson's indices of species at Danzhou Campus of Hainan University

### 4.2.3 Pielou's Evenness Index

The Pielou's evenness index of the four areas of the Danzhou campus of Hainan University fluctuated between 0.2960 and 0.4807. In terms of evenness, the sports field area and the agriculture and forestry avenue area were basically equal, and the plant cultivation was more reasonable. The student dormitory area and the teaching building area have the largest evenness index and are more

diverse in species. In general, the greening of the campus has taken into account the mix of tree species and the distribution of various types of plants is more even [24].

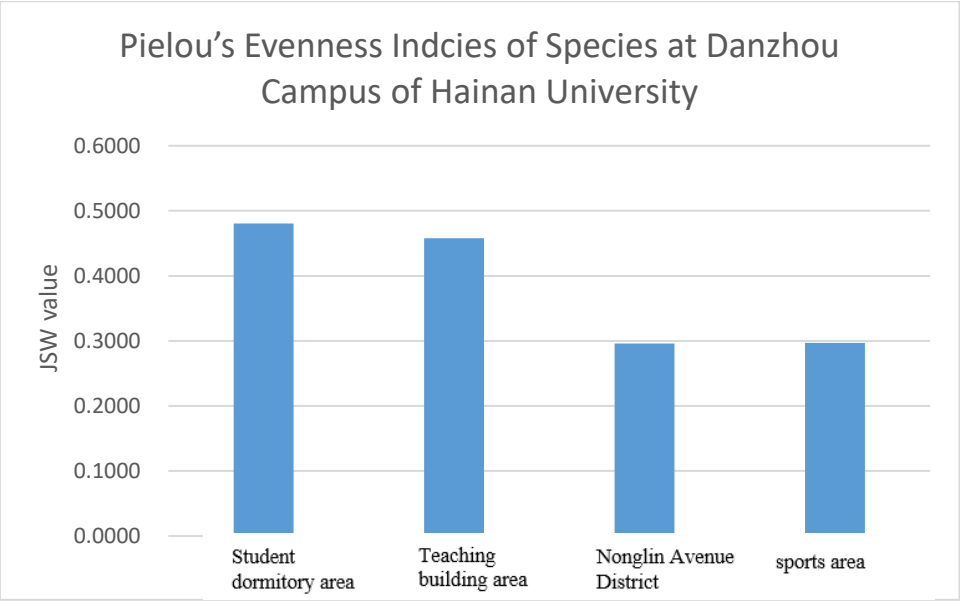


**Figure 3.** Pislou's Evenness Index of Species in Danzhou Campus of Hainan University

## 5. Discussion

This survey shows that Danzhou campus of Hainan University is rich in plant species. There are different plant configurations in different areas, and the main tree species are mainly palmaceae and meliaceae plants, very tropical style. However, palmaceae plants, such as roystonea regia, coconut, etc. are taller. The branches and leaves are easy to fall off after aging, and coconuts fall off after maturity, etc. There are certain safety hazards, and the main road tree species are single. It is recommended to plant other ornamental species and design reasonable configuration to improve the greening rate. At the same time, in some open spaces, it is recommended to plant fruit trees, such as clausena wampi, litchi, etc., to create a regional atmosphere, enhance the practicality and better serve the students and teachers.

The configuration of campus plants in tropical areas should take full account of regional functionality, while combining different flowering periods, as well as the growth habits of different plants, with campus cultural construction, to give full play to the health benefits of trees, repel mosquitoes and insects while playing an excellent shading effect. When selecting tree species, the principles of ecology, economy, ornamental and safety should be comprehensively evaluated to reduce the cost as much as possible and not to increase the additional post-management cost[25] .

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