# Species composition and ethnobotanical values of karst plants: implications for conservation in Padang Bindu, South Sumatra

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## Research

## Abstract

*Background*: Karst ecosystems have high biodiversity with important cultural value, but floristic and ethnobotanical studies are limited, including in the Sumatran Karst. Therefore, this research documents plants diversity and utilization used by The Ogan community in the Padang Bindu Karst.

*Methods*: Data were collected using flora inventory and semi-structured interviews. Analysis included *Important Value Index* (IVI), distribution, conservation status (IUCN), *Invasive Alien Species* (IAS), ethnobotanical value (*Number of Uses* [NUs] and *Cultural Importance Index* [CI]) using R studio software.

*Results*: Padang Bindu Karst has important ecological and socio-economic values. The high biodiversity and community's dependence on key species emphasizes the urgency of community-based conservation through the protection of economically and culturally valuable species, restoration of native species, and participatory control of IAS. Thus, this research provides an integrative contribution among data floristic, conservation status, invasion, and ethnobotany as a model for community-based conservation in South Sumatra.

*Conclusions*: The communities of the Rwenzori region depend a lot on herbal medicine to treat various diseases irrespective of the availability of modern health care.

*Keywords*: Padang Bindu Karst; Ethnobotany, Use value; Cultural importance index, Community-based conservation

## Background

Karst Ecosystems have high levels of biodiversity and endemism, especially for plant groups like ferns, lycophytes, and seed plants (Septiasari *et al*. 2021, Xu *et al.* 2021, delos Angeles *et al*. 2025). Vegetation in this region adapts to extreme conditions, shallow soil, high porosity, and limited nutrients through special morphological and physiological features (Dong *et al*. 2011, Chen *et al*. 2020, Peng *et al*. 2023). Edaphic factor, topography, and micro climate are the main determinants of flora distribution (Ou *et al*. 2020a, Xiao *et al*. 2023, Wang *et al*. 2025), while anthropogenic pressures such as deforestation also affect community structure (Zhao *et al*. 2020, Zhang *et al.* 2021). In Indonesia, floristic research on karst has been quite extensive on Java Island, for example in Somopuro-Klaten (103 spesies; Septiasari *et al*. 2021), Ayah-Kebumen (111 spesies; Indriyani *et al*. 2023), Donorejo-Demak (34 spesies Pteridophyte; Pramudita *et al.* 2023), dan Menoreh-Kulon Progo (55 medicinal plants species; Igustita *et al*. 2023). However, karst areas on other islands, including Sumatra, still lack sufficient studies, although each landscape has distinct floristic and ecological characteristics. This condition, especially in South Sumatra, currently has almost no systematically documented floristic data. Yet, this region keeps important biodiversity and cultural value, while also facing pressures from human activities that potentially threaten the sustainability of the karst ecosystem.

Karst research generally focuses more on fauna and geological aspects (Ning *et al*. 2023), while studies on vegetation and plant utilization are still very limited. Karst plants not only have ecological value, but also play a crucial role for local communities as sources of food, medicine, timber, and ritual materials (Rarasti *et al*. 2025, Safitri *et al*. 2025). Ethnobotanical research from different regions in Indonesia shows that community knowledge of karst vegetation can serve as a strong foundation for conservation efforts. (Iskandar & Iskandar 2021, Igustita *et al*. 2023). Therefore, integrated research between floristics and ethnobotany are needed to understand how plant utilization can support community-based management strategies.

This condition is also reflected in the karst area of Padang Bindu, South Sumatra, which is not only important from an ecological and geological perspective but also holds a strong social, cultural, and historical dimension. Most of the population consists of the Ogan ethnic group, whose daily lives and sources of livelihood are closely connected to the surrounding karst landscape. The presence of prehistoric sites such as Harimau Cave and Putri Cave in Padang Bindu emphasizes the historical and archaeological value of this region (Simanjuntak, 2017), which has long been a living space and a center of community activity. The Ogan community still relies on karst-based agriculture, utilizing underground water sources for domestic needs, and maintaining a connection with the caves and the landscape as part of their cultural identity as well as ecotourism potential.

The integration among floral diversity, cultural history, and community utilization practices makes Padang Bindu a unique karst landscape with high conservation and socio-economic value. However, research conducted in this area has primarily focused on faunal aspects, such as butterflies (Qodri *et al*. 2023), while floristic and ethnobotanical studies are scarce. Based on this condition, integrative studies that connect species composition with local community knowledge are rarely conducted in karst ecosystems, particularly in South Sumatra. The loss of traditional knowledge and increasing environmental pressure have the potential to accelerate ecosystem degradation. This research focuses on documenting plant diversity and its ethnobotanical potential in the Padang Bindu Karst landscape. The findings of this study are expected to not only address the lack of floristic information but also offer a scientific foundation for community-based conservation, while contributing to the goals of SDG 15, which emphasize sustainable forest management, prevention of land degradation and desertification, and the protection of terrestrial biodiversity.

## Materials and Methods

**Study area**

The research was conducted in Padang Bindu Village, Ogan Komering Ulu (OKU) Regency, South Sumatra. This village consists of 10 hamlets and 24 neighborhood units with the majority of the population originating from the Ogan ethnic group. The research area covers a karst landscape with an altitude of 103–294 m asl, relative humidity of 79–90%, and an average daily temperature of 28–31°C. This area is characterized by the presence of large caves, including Putri Cave, Harimau Cave, Silabe Cave, Yemaye Cave, and Candi Cave, which are typical features of the local geomorphology (Figure 1).

**Data collection methods**

Vegetation data were collected using a combination of methods: plot sampling and a walk-through survey. Plots measuring 20 × 20 m were used for trees (DBH ≥ 10 cm), 10 × 10 m subplots for saplings (DBH 2–10 cm), 5 × 5 m subplots for seedlings and shrubs, and 2 × 2 m subplots for herbs, ferns, and mosses. Within each plot, all encountered individuals were recorded for their species name, diameter, and frequency of occurrence. A walk-through survey was conducted to record additional species not found within the plots. Specimens were collected and identified using taxonomic literature, verified with the Bogoriense herbarium collection, and validated by referencing Plants of the World Online (POWO).

A quantitative ethnobotany approach to document and analyze the utilization of plants by the local community was carried out through semi-structured interviews with 20 key informants and 10 community members selected using purposive and snowball sampling (Gaoue *et al*. 2017). Prior to the interview, oral informed consent was obtained from every participant. The information collected included the local species name, the part used, and 14 utilization categories.

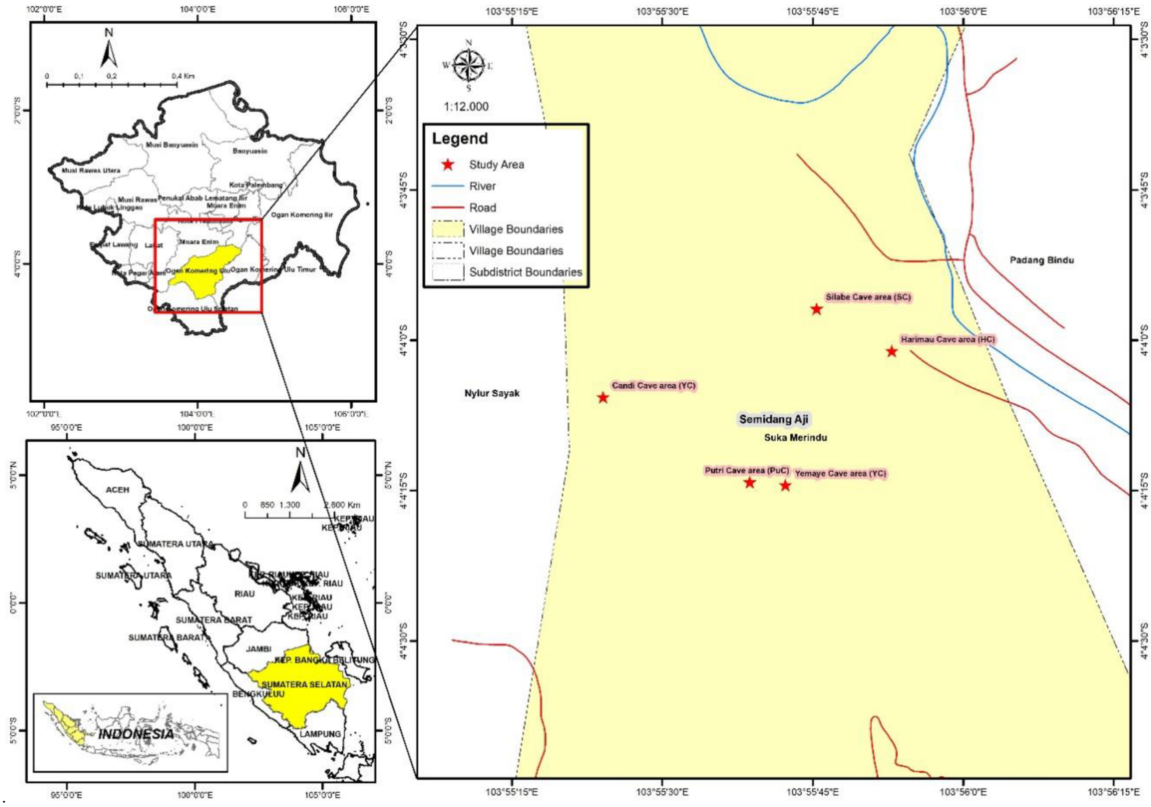


Figure 1. Map of South Sumatra, Caves in the Padang Bindu Karst which are the study area

**Data analysis**

The species distribution status was referenced from POWO, classifying them as native or non-native species, and the species conservation status was verified based on the IUCN Red List of Threatened Species. Meanwhile, the identification of Invasive Alien Species (IAS) was carried out by comparing the inventory lists sourced from the Minister of Environment and Forestry Regulation No. P.94/MENLHK/KUM.1/12/2016, a Guide Book to Invasive Plant Species in Indonesia (Setyawati *et al*. 2015), the National Strategy and Action Plan Directives for Invasive Alien Species Management, as well as the Director General of KSDAE Regulation No. P.4/KSDAE/Set/KSA.2/11/2019, with additional verification through the international databases of CABI & IUCN. Next, ethnobotanical analysis was performed with a quantitative approach using the ethnobotany R package in the R software (Gaoue *et al*. 2021). The calculated index included Number of Uses (NUs) per species (Phillips & Gentry 1993), and the Cultural Importance Index (CI) to assess the diversity of their uses (Tardío & Pardo-de-Santayana 2008). The data were then analyzed integratively by connecting the vegetation composition (Importance Value Index (IVI), conservation status (IUCN), distribution status (native/non-native), ethnobotanical values (NUs and CI), and the presence of IAS (Invasive Alien Species). The integration results were visualized using R, including the construction of a Sankey diagram to illustrate the relationship between conservation status, distribution, and utilization categories.

## Results

**Species composition and diversity**

Species inventory in the Padang Bindu karst successfully documented 234 species belonging to 184 Genera and 104 families. Families with a species count of ≥ 10 are Euphorbiaceae (16 species), Fabaceae (13 species), Araceae (11 species), Annonaceae (10 species), and Malvaceae (10 species). The highest life forms analysis results were the tree group (38.9%), followed by shrubs (18.4%), herbs (17%), and lianas (13.2%). Meanwhile, other groups, such as ferns (9%), bamboo (2.6%), and mosses (0.9%), showed a lower contribution to the total overall species composition (Table 1, Appendix 1). The dominance of trees as the highest life form indicates that this area still had relatively good vegetation cover and a complex structure.

Table 1. Floristic composition and representative species across life forms in the karst Padang Bindu

| Life form | No. of families | No. of genera | No. of species | Total of species (%) | Dominant families/representative species |
|---|---|---|---|---|---|
| Tree | 39 | 71 | 91 | 38.9 | **Euphorbiaceae**, 10 species (*Aporosa octandra* (Buch.Ham. ex D.Don) A.R. Vickery, *Croton caudatus* Geiseler, *Hevea brasiliensis* (Willd. ex A.Juss.) Müll.Arg., *Homalanthus populneus* (Geiseler) Kuntze., *Macaranga tanarius* (L.) Müll.Arg., *Macaranga triloba* (Thunb.) Müll.Arg., *Mallotus mollissimus* (Geiseler) Airy Shaw., *Mallotus moluccanus* (L.) Müll.Arg., *Mallotus philippensis* (Lam.) Müll.Arg., *Neoscortechinia nicobarica* (Hook.f.) Pax & K.Hoffm. |
| Shrub | 20 | 31 | 43 | 18.4 | **Euphorbiaceae,** 6 species (*Acalypha hispida* Burm.f., *Acalypha wilkesiana* Müll.Arg., *Alchornea rugosa* (Lour.) Müll.Arg., *Alchornea parviflora* (Benth.) Müll.Arg., *Claoxylon indicum* (Reinw. Ex Blume) Hassk., *Codiaeum variegatum* (L.) Rumph. ex A.Juss.)<br>**Rubiaceae**, 6 species (*Coffea canephora* Pierre ex A.Froehner., *Pavetta montana* Reinw. Ex Blume., *Pavetta* sp., *Psychotria* sp., *Psychotria viridiflora* Reinw. Ex Blume., *Tarenna dasyphylla* (Miq.) Valeton ex Steenis.) |
| Herb | 19 | 37 | 40 | 17 | **Zingeberaceae**, 7 species (*Alpinia* sp., *Curcuma longa* L., *Eltingera* sp., *Globba* sp., *Meistera aculeata* (Roxb.) Škorničk. & M.F.Newman., *Wurfbainia compacta* (Sol. Ex Maton) Škorničk. & A.D.Poulsen., *Zingiber neglectum* Valteon) |
| Vine | 14 | 25 | 31 | 13.2 | **Araceae**, 7 species (*Anadendrum microstachyum* (de Vriese & Miq.) Backer & Alderw., *Monstera adansonii* Schott., *Pothos brevistylus* Engl., *Pothos junghuhnii* de Vriese., *Pothos scandens* L., *Pothos tener* Wall., *Scindapsus splendidus* Alderw.) |
| Bamboo | 1 | 3 | 6 | 2.6 | **Poacea**, 5 species (*Dendrocalamus asper* (Schult. & Schult.f.) Backer., *Gigantochloa nigrociliata* (Buse) Kurz., *Gigantochloa scortechinii* Gamble., *Gigantochloa* sp., *Schizostachyum* sp., *Schizostachyum zollingeri* Steud.) |
| Fern | 9 | 13 | 21 | 9 | **Polypodiaceae**, 5 species (*Nephrolepis biserrata* (Sw.) Schott., *Phymatosorus membranifolius* (R.Br.) S.G.Lu., *Pyrrosia lanceolata* (L.) Farw., *Pyrrosia piloselloides* (L.) M.G.Price., *Tectaria membranacea* (Hook.) Fraser-Jenk. & Kholia.) |
| Moss | 2 | 2 | 2 | 0.9 | **Plagiochilaceae**, 1 species (*Plagiochila* sp.); **Polytrichaceae** (*Polytrichum* sp.) |
| **Total** | **104** | **183** | **234** | **100** | |

The analysis results of the Importance Value Index (IVI) showed that the vegetation structure of the Padang Bindu karst was formed by key species in each growth stratum. The sapling stratum was dominated by *Neoscortechinia nicobarica*, *Alchornea rugosa*, and *Vitex pinnata*. The pole stratum was dominated by *V. pinnata* and *Aporosa whitmorei*, and the tree stratum was dominated by *V. pinnata* and *Durio zibethinus* (IVI > 20%) (Table 2).

Table 2. Dominant tree species (IVI> 10%) across successional stages in the Padang Bindu karst landscape

| Stratum | Family | Species | ∑ Indv. | IVI (%) | Origin | IUCN |
|---|---|---|---|---|---|---|
| Saplings | Euphorbiaceae | *Neoscortechinia nicobarica* (Hook.f.) Pax & K.Hoffm. | 73 | 39.23 | Native | LC |
| | Euphorbiaceae | *Alchornea rugosa* (Lour.) Mull. Arg. | 54 | 24.48 | Native | LC |
| | Lamiaceae | *Vitex pinnata* L. | 37 | 22.07 | Native | LC |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Myratceae | *Syzygium acuminatissimum* (Blume) DC. | 38 | | | - |
| | Euphorbiaceae | *Alchornea parviflora* (Bent) Mull. Arg. | 21 | 12.76 | Native | LC |
| | Dilleniaceae | *Dillenia obovate* (Blume) Hoogland. | 24 | 12.35 | Native | LC |
| | Rubiaceae | *Pavetta montana* Reinw. ex Blume | 20 | 12.10 | Native | - |
| | Malvaceae | *Microcos tomentosa* Sm. | 17 | 10.01 | Native | - |
| Poles | Lamiaceae | *Vitex pinnata* L. | 27 | 47.53 | Native | LC |
| | Phyllanthaceae | *Aporosa whitmorei* Airy Shaw | 11 | 20.24 | Native | LC |
| | Sapindaceae | *Harpurallia arborea* (Blanco) Radlk. | 8 | 15.85 | Native | LC |
| | Malvaceae | *Microcos tomentosa* Sm. | 6 | 14.29 | Native | - |
| | Malvaceae | *Pterospermum javanicum* Jungh. | 7 | 12.50 | Native | LC |
| | Hypericaceae | *Cratoxylum formosum* (Jack) Benth. & Hook.f. ex Dyer | 7 | 12.39 | Native | LC |
| | Moraceae | *Ficus hispida* L. f. | 7 | 11.78 | Native | LC |
| | Theaceae | *Schima wallichii* (DC.) korth. | 6 | 11.08 | Native | - |
| Trees | Lamiaceae | *Vitex pinnata* L. | 11 | 29.92 | Native | LC |
| | Malvaceae | *Durio zibethinus* L. | 4 | 22.65 | Native | - |
| | Lecythidaceae | *Barringtonia racemosa* (L.) Spreng | 6 | 19.62 | Native | LC |
| | Sapindaceae | *Harpullia arborea* (Blanco) Radlk | 6 | 17.92 | Native | LC |
| | Phyllanthaceae | *Aporosa whitmorei* Airy Shaw | 6 | 16.04 | Native | LC |
| | Lamiaceae | *Tectona grandis* L.f | 5 | 13.50 | Native | VU |
| | Moraceae | *Artocarpus elasticus* Reinw. ex Blume | 4 | 12.79 | Native | LC |
| | Euphorbiaceae | *Alchornea rugosa* (Lour.) Mull Arg. | 4 | 10.79 | Native | LC |
| | Theaceae | *Schima wallichii* (DC.) Korth. | 4 | 10.37 | Native | - |

**Conservation and Alien Invasive Species (IAS) status**

From the total species in Padang Bindu karst (234 species), there were 186 native species and 48 non-native species, with 92 species listed on the IUCN Red List. The species include Least Concern (LC, 85 species), Near Threatened (NT, 1 species), Vulnerable (VU, 4 species), Endangered (EN, 1 species), and Critically Endangered (CR, 1 species). Further distribution based on vegetation type, origin, and conservation status was visualized in a sunburst diagram (Figure 2). Meanwhile, 7 IAS were recorded, most of which were included in national regulations and the remainder were listed in global data (Table 3).

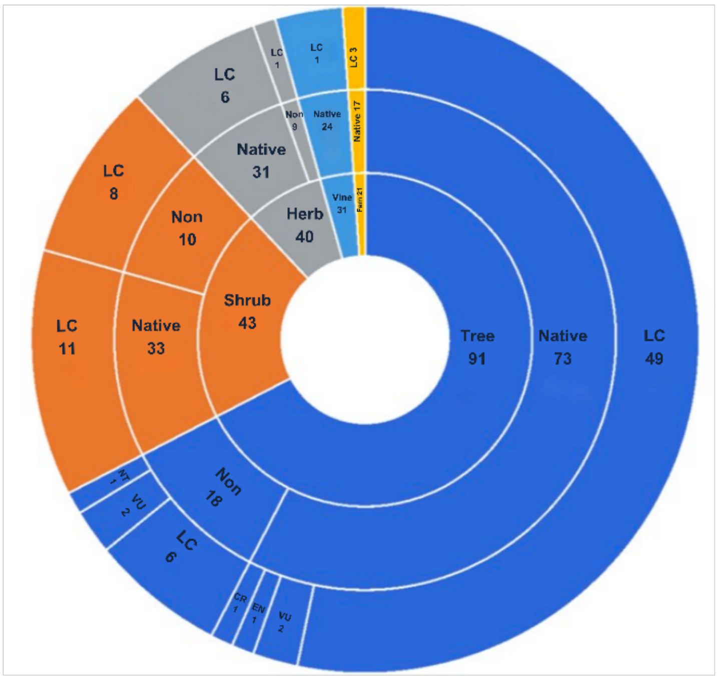


Figure 2. Distribution of vegetation origin and IUCN status in the Karst Landscape of Padang Bindu

Table 3. Invasive plant species recorded in the Padang Bindu karst landscape.

| | Reference of invasive status | Information |
|---|---|---|
| *Commelina benghalensis* L. | Global invasive (CABI/ISSG) | This perennial creeping herb with effective generative and vegetative reproduction is a global invasive species with high genetic homogeneity that suppresses native flora and cultivated crops, making it difficult to manage (Fibrich & Lall 2020); although not yet listed in the Ministry of Environment and Forestry Regulation P.94, its status is globally recognized. |
| *Hyptis capitata* Jacq. | Reported as locally invasive. (Setyawati *et al*. 2015) | Originating from tropical America and having been reported as invasive in Southeast Asia, including Indonesia, this species possesses high reproduction, phenotypic plasticity, and broad adaptation that allows it to escape natural enemies. Its invasion has the potential to reduce biodiversity and alter ecosystem function (Shah 2024), although it is not yet listed in the Ministry of Environment and Forestry Regulation P.94. |
| *Melastoma malabatricum* L. | Reported as locally invasive. (Setyawati *et al*. 2015) | *M. malabathricum is a common primary weed in industrial plantation forests and has been reported to infest mahogany crops in Sumatra (Master et al. 2020). This species is also listed as a Federal Noxious Weed* in the United States. |
| *Miconia crenata* (Vahl) Michelang. (Syn: *Clidemia hirta*) | Ministry of Environment and Forestry Regulation P.94 | This aggressive invasive weed originating from tropical America is broadly adapted, spreads via birds and wild boars, and suppresses native species and hinders restoration. Management is suggested through the utilization of fruit and biological control (Kumar & Rajendraprasad, 2025). |
| *Piper aduncum* L. | Ministry of Environment and Forestry Regulation P.94 | This invasive shrub originating from Central America features rapid growth, abundant seed dispersal, and strong allelopathy that suppresses other vegetation. This invasion reduces biodiversity and disrupts agriculture, but its biomass has potential for renewable energy. (Hartemink 2010, Rantael *et al.* 2022). |
| *Senna siamea* (Lam.) H.S.Irwin & Barneby (Syn. *Cassia siamea* L.) | Ministry of Environment and Forestry Regulation P.94 | This fast-growing tree is tolerant of various conditions, is often planted for shade, and easily spreads through human activity. Its invasion displaces native species, alters ecosystems, and incurs high control costs. (Ni *et al.* 2018). |
| *Urena lobata* L. | Ministry of Environment and Forestry Regulation P.94 | This invasive weed, Caesar Weed, possesses high germination, wide environmental tolerance, and easy dispersal, consequently reducing biodiversity and causing harm to the agricultural and forestry sectors. (Awan *et al*. 2014). |

**Ethnobotany value and high economic species**

The visualization of the relationship between species and utilization categories shows that the families Fabaceae, Moraceae, and Annonaceae are the most widely utilized for food, medicine, and material resources. The families Zingiberaceae and Euphorbiaceae also contribute significantly to medicinal and food uses, despite having a limited number of species (Figure 3). Species with more than three utilizations are *D. zibethinus*, *Eurya acuminata*, and *Kleinhovia hospita* (Figure 4). *D. zibethinus* holds the highest position for both CI (0.167) and NUs (5) with utilization categories for food source, medicine, building materials, fuelwood, and animal feed. *E. acuminata* and *K. hospita* have CI (0.133) and NUs (4) with different utilization categories. Meanwhile, other species have CI values (0.067) and NUs (2) (Figure 5-6, Appendix 2). A total of 12 high economic value species that have been cultivated by the community include *Annona reticulata*, *A. malaccensis*, *Archidendron jiringa*, *Artocarpus elasticus*, *Artocarpus integer*, *Averrhoa bilimbi*, *Coffea canephora*, *D. zibethinus*, *Garcinia parviflora*, *Hevea brasiliensis*, *Lansium domesticum*, and *Tectona grandis*. Besides this group of trees, several non-timber species from the families Araceae, Apocynaceae, and Orchidaceae also show high economic potential as ornamental plants with aesthetic and commercial value (Appendix 1). Species such as *Aglaonema pictum*, *Monstera adansonii*, *Scindapsus splendidus*, as well as some terrestrial orchids like *Calanthe triplicata* and *Nervilia concolor*, and *Hoya coronaria* show high ornamental value and are in demand in the ornamental plant trade.

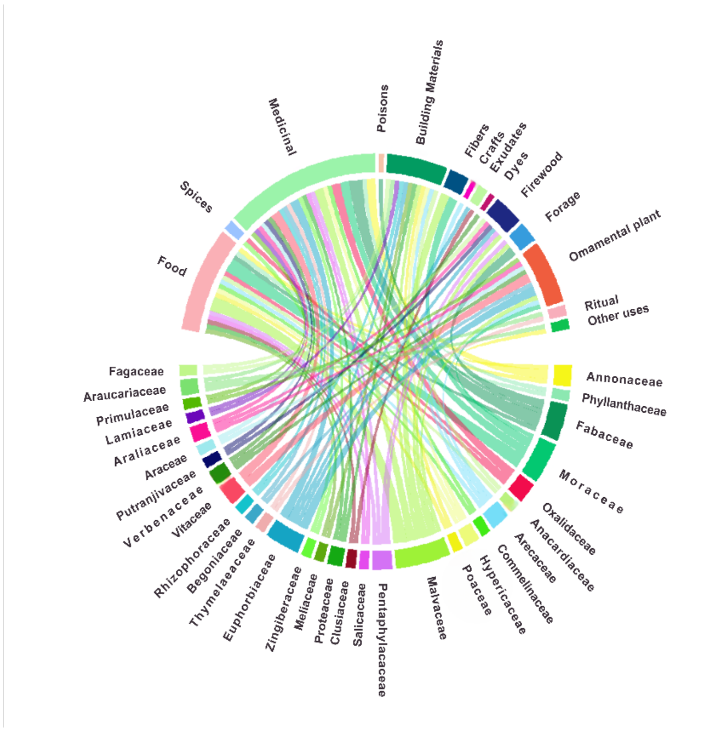


Figure 3. Relationship between plant families and ethnobotanical use categories

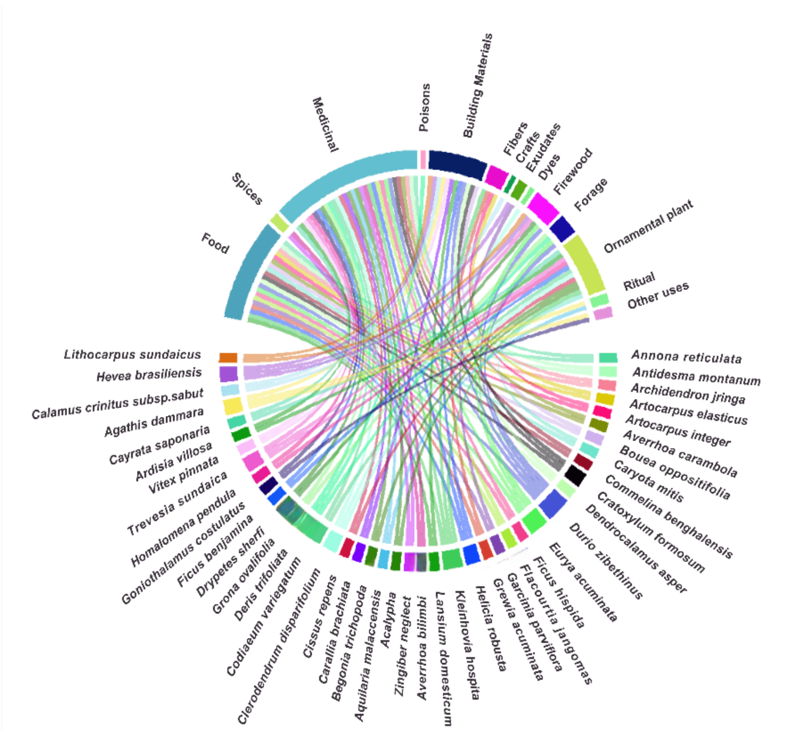


Figure 4. Relationship between plant species and ethnobotanical use categories

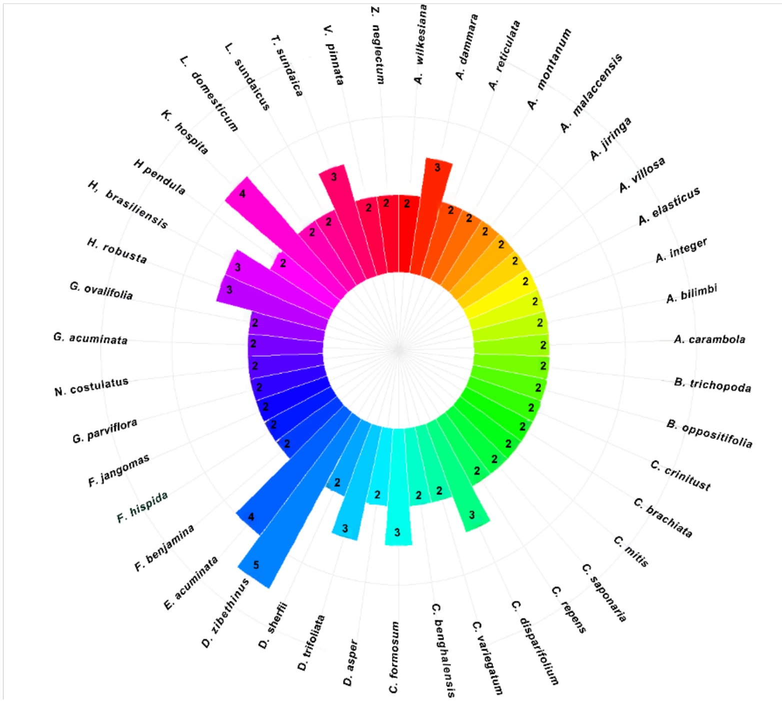


Figure 5. Number of use categories (NUs) of recorded plant species

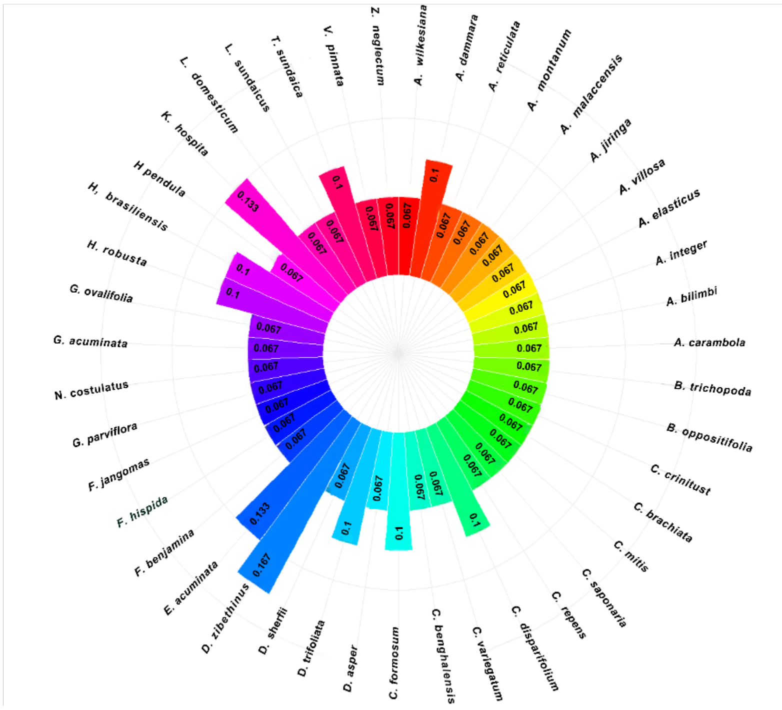


Figure 6. Cultural importance index (CI) of recorded plant species

**Integration of ecology, conservation, and ethnobotany**

Results of the integrated analysis among conservation status, distribution, and utilization patterns show a complex relational pattern, consisting of 36 native species (83.7%) and 7 non-native species (16.3%) (Figure 7). The conservation status of the species is dominated by the Least Concern (LC) category with 26 species (60.5%) and Not Evaluated (NE) with 14 species (32.6%). Meanwhile, the other three species are included in the Critically Endangered (CR), Endangered (EN), and Vulnerable (VU) categories, with one species each (2.3%). The highest utilization patterns are dominated by the medicinal category with 31 species (72.1%), food with 22 species (51.2%), construction material with 11 species (5.6%), ornamental plants with 8 species (18.6%), and fuelwood with 7 species (16.3%). Based on the IUCN Red List, three threatened species were recorded: *Agathis dammara* (VU), *Goniothalamus costulatus* (EN), and *Aquilaria malaccensis* (CR), which are still utilized for medicinal and ritual purposes. This condition indicates the presence of anthropogenic pressure that potentially accelerates their population decline. The fact that these threatened species are still being utilized by the community highlights both a potential and a challenge in conservation efforts (Appendix 2).

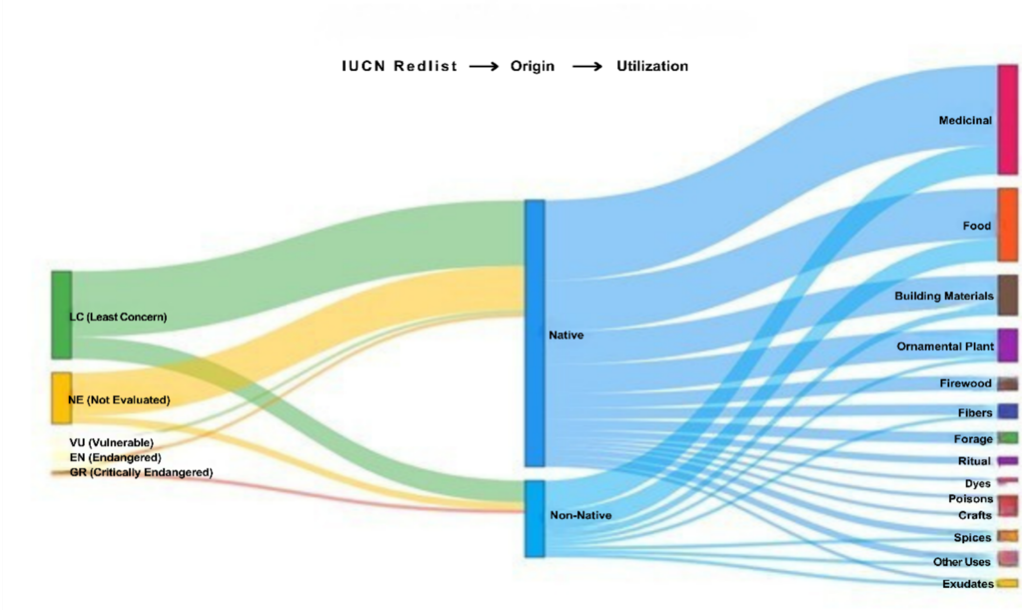


Figure 7. Sankey diagram, the relationship among status, distribution, and utilization

## Discussion

Research results indicate that the Padang Bindu karst landscape has a significantly high flora diversity, with 234 species from 84 families (Table 1, Appendix 1). This number significantly surpasses the diversity of other karst areas in Java, such as Somopuro, Pacitan (103 species; Septiasari *et al*. 2021), Ayah Village, Kebumen (111 species; Indriyani *et al*. 2023), Gawang Hamlet, Pacitan (65 species; Safitri *et al*. 2025), and Menoreh (55 species; Igustita *et al*. 2023). This clear regional variation underlines the complex influence of specific regional ecological conditions on species composition. However, it should be noted that the Pteridophyta group in Padang Bindu, totaling 21 species, is still lower compared to Donorejo, Purworejo, which recorded 34 species (Pramudita *et al*. 2023), suggesting habitat specialization or exploration intensity. This reinforces the view that the edaphic complexity and topographical heterogeneity of karst are both limiting and directing factors in the formation of vegetation community structure.

The IVI analysis results (Table 2) show that most dominant species across all strata are native types with an LC conservation status. The dominance of Vitex pinnata in nearly all growth strata affirms its important ecological role in maintaining community stability and karst ecosystem function. According to Guinde *et al.* (2023) and Nursanti *et al*. (2021), the genus Vitex has a high adaptability to nutrient-poor habitats and often associates positively with other tree species, making it a principal constituent species and a potential candidate for restoration activities. The dominance of woody vegetation also reflects relatively stable and structurally complex ecosystem conditions, with significant contributions from economically valuable trees such as *D. zibethinus* and *Barringtonia racemosa* in providing ecosystem services, whether as carbon storage, food sources, or local economic support (Geekiyanage *et al*. 2019, Goldscheider 2019, Kumilamba *et al*. 2025).

Of the total species recorded, 79% are native species and 21% non-native, with about 39% of them listed on the IUCN Red List (Figure 3, Appendix 1). The majority fall into the categories of LC (92%), VU (5%), EN (1%), NT (1%), and CR (1%), reflecting the presence of plant groups with levels of vulnerability to high threat. The presence of *A. malaccensis* (CR) affirms the importance of protecting economically valuable species that are vulnerable to exploitation and habitat degradation. The high proportion of native species indicates that this landscape is still relatively natural, although the presence of non-native groups indicates increasing anthropogenic pressure. A similar pattern is also found in other karst areas, such as Sangkulirang, East Kalimantan, which has high diversity with important endemic species (Salas *et al*. 2005), as well as Gunung Sewu, Yogyakarta, where restoration efforts are constrained by the dominance of exotic species that reduce native flora richness (Putri *et al*. 2025). These findings suggest that the dynamics of karst flora are always in a fragile balance between ecological potential and anthropogenic pressure.

The presence of Invasive Alien Species (IAS) in Padang Bindu also presents a unique challenge. Out of 49 non-native species, seven were identified as IAS (Table 3). The presence of IAS can inhibit the regeneration of native species and alter community structure, although some species like *Commelina benghalensis* are still utilized by the community for medicine and food. This creates a conservation dilemma. This condition is consistent with findings in Bantimurung Bulusaraung, where *Swietenia macrophylla* and *Maesopsis eminii* have spread into natural karst forests and threaten *Ficus* spp. (Mas'ud *et al*. 2023, Yelastri *et al*. 2023). Similar patterns are also recorded in Laiwangi-Wanggameti, Sumba, as well as in West Java, where *Cecropia peltata* and *Clidemia hirta* dominate the karst soil seed bank (Damayanto & Ervianti 2020, Putri *et al*. 2021). Anthropogenic pathways such as land clearing and shifting cultivation are suspected to be the main entry points for IAS spread. Species like *Miconia crenata* and *Commelina benghalensis* have been proven to suppress the regeneration of native trees (Riar *et al*. 2016, Kumar & Rajendraprasad 2025). Thus, the conservation of Padang Bindu karst needs to integrate invasive species control with a community-based approach so that the socio-economic value of species is still considered without compromising ecosystem stability.

Ethnobotanical analysis reveals a close relationship between floral diversity and local knowledge system of the Ogan community. Out of 43 utilized species, the medicinal (72%) and food (51%) categories dominate. *D. zibethinus* (UV 5.0; CI 5) is utilized in a multifunctional way, serving as a source of food, medicine, timber, and even for ritual activities (Figures 5 and 6). Other species, *Eurya acuminata*, *Clerodendrum disparifolium*, *Cratoxylum formosum*, and *Derris trifoliata* also show significant cultural and economic value, serving as traditional medicine, firewood, and livestock feed. According to Iskandar & Iskandar (2021), although the number of utilized species is relatively limited due to the nutrient-poor karst edaphic conditions and anthropogenic pressure, as well as changing lifestyles that potentially erode traditional knowledge. However, the CI values for certain species remain high, reflecting the community's dependence on a small number of key species. At the family level, Fabaceae, Moraceae, and Annonaceae have the broadest connection to various utilization categories, and this pattern is also found in the Menoreh and Paranggupito karst areas (Igustita *et al*. 2023, Rarasti *et al*. 2025), emphasizing that these families play a vital role in providing ecosystem services that support community life. A total of 12 high economic value species has been locally cultivated, particularly *C. canephora*, *D. zibethinus*, *H. brasiliensis*, and *T. grandis*. This group directly contributes to the household economy, serving as sources of food, building materials, and local trade commodities such as timber and non-timber forest products (NTFPs).

In addition to the timber and food-value groups, the research findings also confirm a high economic potential from the non-timber ornamental group, especially from the Araceae, Apocynaceae, and Orchidaceae families, which grow naturally in the damp and rocky habitats around caves and karst forests. This group is known for the unique beauty of its leaf shapes and colors, giving it high ornamental and commercial value in the ornamental plant trade, while also being important as a source of germplasm (Rahayu *et al*. 2018, Croat & Ortiz 2020, Negi *et al*. 2024). In addition to their ornamental appeal, these plant groups help maintain microhabitat moisture and contribute to the stability of cave ecosystems (Indriyani *et al*. 2023, Yang *et al*. 2025). The presence of these high-economic-value ornamental plants confirms that the Padang Bindu karst flora has significant non-timber bioeconomic potential, which can be developed through community-based conservation and sustainable cultivation. Domestication efforts and the development of a creative economy based on local ornamental plants can be an alternative strategy to reduce exploitation pressure on wild populations while improving the welfare of the surrounding community. The presence of these highly economically valuable ornamental plants confirms that the Padang Bindu karst flora has significant non-timber bioeconomic potential, which can be developed through community-based conservation and sustainable cultivation. Domestication efforts and the development of a creative economy based on local ornamental plants could be an alternative strategy to reduce exploitation pressure on wild populations while improving the well-being of surrounding communities.

The socio-cultural context of the Ogan community reinforces the dimension of conservation based on local wisdom. Most residents rely on agricultural commodities such as rubber, coffee, and teak for their livelihoods, while the karst forest, known locally as *hutan karang* (coral forest), is protected through unwritten customary rules that prohibit planting rubber in that area. This rule has proven effective in maintaining the integrity of the natural habitat and supporting the regeneration of native species. Large caves, such as Putri Cave and Harimau Cave, not only have high ecological and archaeological value but also serve as a source of clean water and a symbol of the community's cultural identity (Simanjuntak 2017). These practices reflect the concept of eco-cultural resilience (Bi *et al*. 2020), where the interaction between cultural and ecological values creates an adaptive system that sustains the permanence of the karst landscape. This pattern of social-ecological adaptation indicates that the Ogan community acts not only as users but also as custodians of the karst landscape, making Padang Bindu a tangible example of management and conservation based on cultural values.

The community's dependence on high economic and cultural value karst flora indicates a strong relationship between biodiversity and local socio-economic resilience. However, overexploitation of key species can threaten population sustainability, making community-based conservation and landscape-based conservation approaches highly relevant. Developing a bioeconomy based on local plants through non-timber forest products such as medicinal, food, and cosmetic products can be a dual strategy that integrates conservation and welfare improvement (Aleru *et al*. 2025, Krainovic *et al*. 2025). Conservation at the landscape scale tends to be more resilient to climate change and anthropogenic pressures compared to single interventions (Ou *et al*. 2020b). Restoration is considered the most effective strategy for conserving limestone landscapes, as it can enhance the soil's physico-chemical properties, increase organic matter, and lower the risk of rocky desertification (Zhang *et al*. 2024).

Restoration based on native species has the potential to strengthen the sustainability of the Padang Bindu karst landscape. Empirical evidence shows that vegetation restoration in karst areas significantly increases biodiversity and ecosystem services (Gairola *et al*. 2023, Chen *et al*. 2024). Local species utilized by the community (Figure 4, Appendix 2) should be a priority for restoration, especially those with cultural value and keystone species such as Ficus, which plays an important ecological role (Segar *et al*., 2017, Petelka *et al*. 2022). Restoration is also essential for establishing ecological corridors, which help link conservation areas and have been shown to enhance habitat connectivity for endemic species, support genetic exchange, and improve ecosystem resilience to climate change (Liu *et al*. 2018). By integrating community-based conservation, native species restoration, participatory invasive species control, and sustainable bioeconomy development, Padang Bindu can serve as an adaptive and inclusive model for Indonesian karst management. The integration of ecological, social, and cultural dimensions makes this area not only a center for biodiversity but also a representation of how conservation can be rooted in local knowledge and community identity.

## Conclusion

The Padang Bindu karst landscape has high floral diversity (234 species), the majority being native species, including groups ranging from vulnerable to threatened and a number of Invasive Alien Species. This finding not only fills the gap in floristic data for South Sumatra, which previously lacked sufficient study, but also adds an ethnobotanical dimension rarely integrated into karst studies in Indonesia. Analysis results show that plant utilization by the Ogan ethnic community is dominated by medicinal and food categories, with key species like *D. zibethinus* and *E. acuminata* having high Use Values and Cultural Importance. At the family level, Fabaceae, Moraceae, and Annonaceae affirm their significant contribution to the provision of ecosystem services, demonstrating a close link between biological diversity and the socio-economic resilience of the community. Conceptually, this research provides an important contribution by linking floristic data, conservation status, the issue of invasive species, and ethnobotanical value into a single ecological-social analytical framework. The strategic implications of these results are the need for community-based conservation that protects key species with economic and cultural value, restoration based on adaptive native species by utilizing keystone and cultural species, and participatory control of Invasive Alien Species. With this integrative approach, Padang Bindu has the potential to become a national model for ethnobotany-based conservation, where the protection of biodiversity goes hand-in-hand with strengthening the community's socio-economic system. The novelty of this study stems from its integration of floristic data, ethnobotanical insights, and conservation perspectives within a single karst-focused assessment, positioning Padang Bindu as the first case in South Sumatra to propose a management framework grounded in scientific evidence and local knowledge. These findings are not only relevant for local-level conservation but also contribute to the global discourse on the sustainable management of tropical karst landscapes

## Declarations

**List of abbreviations:** Not applicable

**Ethics approval and consent to participate:** Not applicable

**Consent for publication:** Not applicable

**Availability of data and materials:** All the data related to the present study is included in the manuscript

**Competing interests:** The authors declare that they have no conflict of interest

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**Author contributions:** Y. conceptualization, collected and analyzed data, investigation, and writing-original draft. M.S. analyzed data, reviewing, and editing. D.H. investigation and editing. S. collected data and reviewing, ME: collected the data and reviewing. D.G. collected the data and reviewing. R.P.M. reviewing and editing. A.S. reviewing and editing. H.H. reviewing and editing. S.S. reviewing and editing. All authors participated in reading, revising, reviewing, and approving the final draft of the manuscript.

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