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The threatened plant species in Central Kalimantan of Indonesia and its utilization potencies

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Abstract. According to the IUCN Red List of plant species in Indonesia in 2021, the amount and the status of those threatened plant species are one *Extinct*, three *Extinct in the Wild*, and 856 *Critically Endangered*, *Endangered*, and *Vulnerable*. The ex-situ plant conservation of the threatened plants becomes very urgent in Indonesia including in Kalimantan. The purpose of this study is to find out the species and the categories of the threatened plant species distributed in Central Kalimantan of Indonesia, as well as their potential utilization. At least 125 threatened plant species of Indonesia were distributed in Central Kalimantan. The plant family with the greatest number of threatened plant species distributed in Central Kalimantan was Dipterocarpaceae (46 spp), and Myristicaceae (12 spp). In the total of those threatened plant species, 2 spp were in the category of Extinct in the Wild (EW), 16 spp Critical Endangered (CR), 30 spp Endangered (EN), and 77 spp Vulnerable (VU). Those species had the potency to be utilized for timber, food source/fruit, medicinal, and ornamental plants. The district that possessed the most threatened plant species was Katingan (40 spp.) followed by Kotawaringin Timur (37 spp.), Murung Raya (35 spp.), and Barito Utara (29 spp).

1. Introduction

Plant diversity is the biggest capital in human life. Humans are very dependent on plants to carry out their lives in the world. It is estimated that there are around 450,000 plant species living in the world, two-thirds of which are in the tropics [1], and only 140,600 species have been described in detail [2]. Indonesia as a country located in the tropical area is one of the mega-biodiversity countries. The country has around 15.5% of the world's flora diversity with a high level of endemism. About 40-50% of the endemic species were recorded from the total flora species on each island, except for the island of Sumatra which is estimated at only 23% of endemism [3].

The biodiversity population currently has been an increasing threat of extinction as the human population increase. The urge to fulfil human needs has led to the overexploitation of biological resources which has resulted in many species facing the threat of extinction and even extinction. Therefore, sustainable conservation action is needed so that this condition does not get worse. To support this action, comprehensive data on species populations and threats are needed. As a crucial indication of the health of the world's biodiversity, the International Union for Conservation of Nature and Natural Resource (IUCN) Red List serves data on range, population size, habitat, ecology, use and/or commerce, threats, and conservation efforts to help guide important conservation decisions [4].

Based on IUCN Red List data for the year 2021, in Indonesia there were 1 species of plant was Extinct (EX), 3 species were already Extinct in the Wild (EW) and 856 species were in the Critically Endangered (CR), Endangered (EN), and Vulnerable (VU) status [4, 5]. These species face a high threat



of extinction in the habitat and require effective and comprehensive conservation efforts for remaining sustainable manner and can be utilized by humans in the future continuously. Ex situ conservation has a very important role in rescuing threatened plants. Botanical Gardens are key institutions and have proven effective in ex-situ plant conservation efforts. Currently, only 20.4 % of threatened plants have been conserved ex-situ in Botanical Gardens in Indonesia. Meanwhile, based on the Global Strategy for Plant Conservation (GSPC), the target for ex situ conservation of endangered plants by 2020 was 75 % [6]. Thus, ex situ conservation activities of endangered plants in Botanical Gardens in Indonesia, including in Regional Botanical Gardens are very urgent and must be improved continuously to achieve these targets. Botanical gardens have five functions, including conservation and research. The collections of species in the Botanical Gardens include those that are threatened or have economic potential that needs to be developed.

Kalimantan is an Indonesian territory that has the second-highest relative abundance and endemism of plant species after Papua [7]. The high diversity of plants in the forests of Kalimantan can also be seen from the distribution in one hectare which can grow more than 150 different species of trees [8]. The potential utilization of plant diversity in Kalimantan is also very high. But on the other hand, the threat of plant extinction in Kalimantan has great potential as a result of the loss of natural habitats and the high rate of deforestation caused by humans or natural disasters. This was reflected in the large total area of deforestation in Kalimantan which reached 128,019.1 Ha in 2019 [9]. Currently, there are obtainable data on threatened plant species in the world including in Indonesia [4]. Furthermore, information on the distribution of these species' habitats [5], including species distributed in Kalimantan [7-8, 10] is also available. On the other hand, the data on plant species that have been collected in the Indonesian Botanical Gardens are also already accessible [11-13]. There was also information on the number of plant species that were utilized for timber, and other uses [14]. This data and information are very important as a reference for making a list of threatened species from Central Kalimantan as targets for ex-situ collection and domestication.

The ex-situ conservation and domestication research of threatened plants become more focused and clearer on their achievements. The exploration and collection activities are expected to be conducted to support the efforts to achieve the GSPC targets that have been set and to assist the further studying of the potential utilization of collected plants through domestication programs. The purpose of this study is to find out the species, the categories of the threatened plant species distributed in Central Kalimantan, and their potential utilization.

2. Materials and Methods

The data of all threatened plant species of the world and its threatened categories of Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), and Vulnerable (VU) were compiled from the IUCN Red List Website [4]. The data from the Red List of plant species, which included the categories of Near Threatened (NT), Least Concern (LC), and Data Deficient (DD) were not included in the list of the threatened plants in this paper. The data of the threatened plant species then were confirmed with accepted species names (from the Plant of The World Online/POWO) and then completed with the family and genera of the species [2]. Moreover, the information on the distribution locations of those species was gathered from the Global Biodiversity Information Facility (GBIF) [5] and the related reference [10]. The data of the GBIF included the coordinate locations of the threatened plant species. Therefore, it could be determined the threatened species from Indonesia, especially those located in Central Kalimantan province. Furthermore, the potencies of the threatened plants distributed in Central Kalimantan province were determined according to the references [14]. Then the species was compiled/selected according to the distribution location (district and subdistrict) on the list, especially in Central Kalimantan province [5]. The flowchart of the methodology of this study is presented in Figure 1.

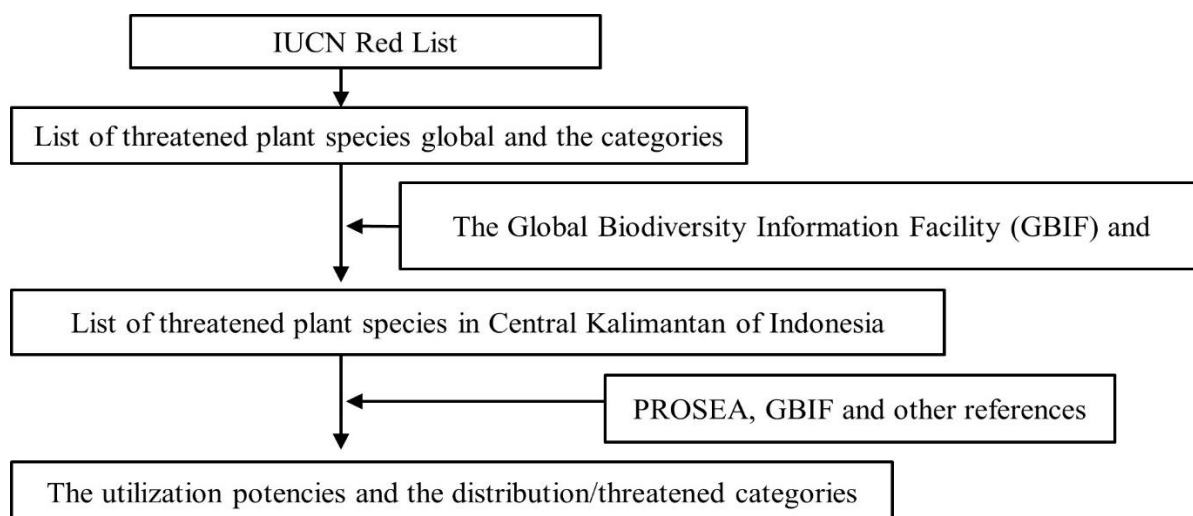


Figure 1. Flow chart of the study methodology

3. Results and Discussion

The compilation of the IUCN Red List of threatened plant species in Indonesia distributed in Central Kalimantan is shown in Figures 2 to 6. Those compilations included the number of plant families, genera, and species; the threatened categories of the species, the distribution of those threatened species in Central Kalimantan; and the threatened categories of the species distributed in Central Kalimantan.

3.1. Family, genera, and species of threatened plants that distributed in Central Kalimantan

There were at least 125 species of plants on the IUCN Red List of Indonesia from 25 families, distributed in Central Kalimantan (Figure 2). Those families were Anacardiaceae, Anisophylleaceae, Annonaceae, Apocynaceae, Araucariaceae, Burseraceae, Ctenolophonaceae, Dilleniaceae, Dipterocarpaceae, Fabaceae, Fagaceae, Lamiaceae, Lauraceae, Malvaceae, Meliaceae, Moraceae, Myristicaceae, Nepenthaceae, Orchidaceae, Phyllantaceae, Podocarpaceae, Sapotaceae, Tetrameristaceae, Thymelaceae, and Zingiberaceae. Each of those families comprised 1 to 7 genera and 1 to 46 species (Figure 2). Seventeen families comprised 1 genus, three families consisted of 2 genera, two families comprised 3 genera, and one family consisted of 4, 6, and 7 genera. On the other hand, 12 families comprised of 1 sp, 4 families comprised of 7 spp, 3 families consisted of 3 spp, 2 families comprised of 5 spp, and 1 family comprised of 6, 12, and 46 spp. (Figure 2). The greatest number of genera and species of those families were Dipterocarpaceae (6 genera and 46 spp), Zingiberaceae (7 genera and 7 spp), and Myristicaceae (3 genera and 12 spp) (Figure 2). The genera of Dipterocarpaceae were *Anisoptera*, *Cotylelobium*, *Dipterocarpus*, *Hopea*, *Shorea*, and *Vatica*. The genera of Zingiberaceae were *Alpinia*, *Burbidgea*, *Epimomum*, *Etlingera*, *Meistera*, *Myxochlamys*, *Sundamomum*, and those of Myristicaceae were *Horsfieldia*, *Knema*, and *Myristica*. Another study in South Kalimantan, namely the Kinarum Protected Forest mentioned that as many as 42 spp included in the IUCN Red List plants recorded, including those of the family Meliaceae, Moraceae, Sapindaceae, Myristicaceae and Dipterocarpaceae [15]. However, those plants have an average Important Value Index of less than 10% and the species abundance index was close to zero [15]. This indicated urgent conservation action needed to protect the threatened plant species in Kalimantan of Indonesia.

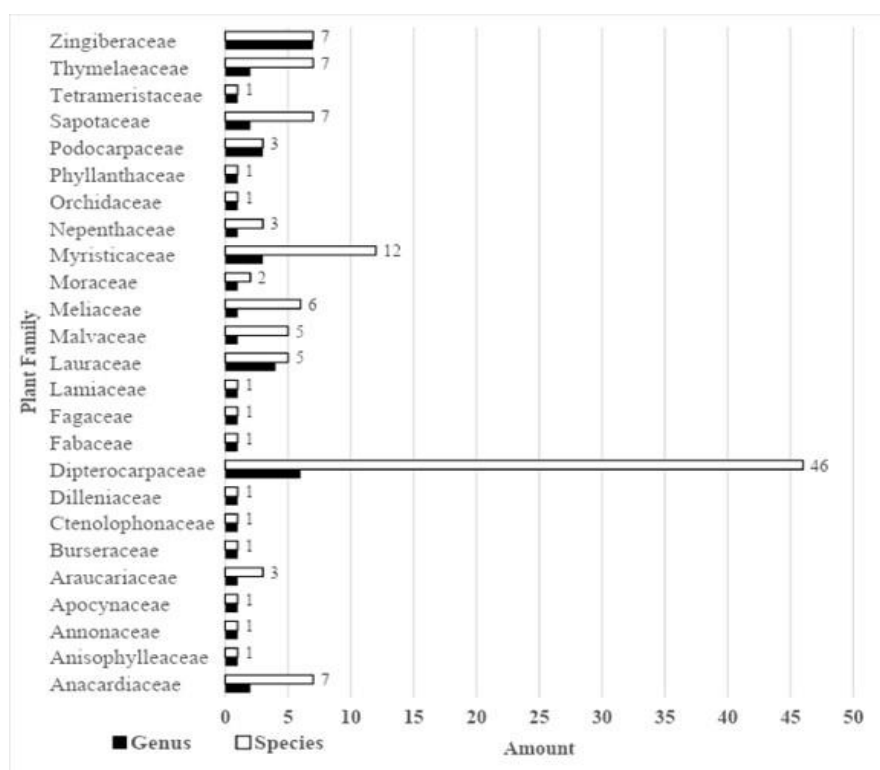


Figure 2. The number of genera and the species of each plant family of threatened plants distributed in Central Kalimantan

3.2. The categories of threatened plant species in Central Kalimantan

From a total of 125 threatened plant species from 25 families, 2 spp were in the category Extinct in the Wild (EW), 16 spp Critical Endangered (CR), 30 spp Endangered (EN), and 77 spp Vulnerable (VU) (Figure 3). Both species with the category Extinct in the Wild (EW) were from the family Anacardiaceae, namely *Mangifera rubropetala* Kosterm. and *M. casturi* Kosterm. Whereas, sixteen species with the threatened categories Critically Endangered (CR) were those from the families Dipterocarpaceae (10 spp.), Nepenthaceae (2 spp.), Thymelaeaceae (2 spp.), Orchidaceae (1 sp.), and Zingiberaceae (1 sp.) (Figure 3). Thirty species in Central Kalimantan possessed the threatened category were those from the families Dipterocarpaceae (13 spp.), Zingiberaceae (4 spp.), Araucariaceae (2 spp.), Sapotaceae (2 spp.), Anacardiaceae (1 sp.), Fabaceae (1 sp.), Lamiaceae (1 sp.), Lauraceae (1 sp.), Podocarpaceae (1 sp.) and Thymelaeaceae (1 sp.) (Figure 3). On the other hand, seventy-seven species with the category Vulnerable (VU) were 23 spp. from the family Dipterocarpaceae; 9 spp. of Myristicaceae; 6 spp of Maliaceae; 5 spp. of Sapotaceae and Malvaceae; 4 spp. of Anacardiaceae, Lauraceae, and Thymelaeaceae; 2 spp. of Moraceae, Podocarpaceae, and Zingiberaceae; 1 sp. of Anisophylaceae, Annonaceae, Apocynaceae, Araucariaceae, Burseraceae, Ctenolophonaceae, Dilleniaceae, Fagaceae, Nepenthaceae, Phyllantaceae, and Tetrameristaceae (Figure 3). Another study in the protected forest in South Kalimantan of Indonesia reported that 42 spp from 121 plant species found were included in the IUCN Red List, i.e. 8 spp of threatened species (CR, EN, and VU), 33 spp Least Concern (LC), and 1 sp. Data Deficient (DD) [15].

Besides the increase in human population and the overexploitation of biological resources by human beings, environmental problems could affect the threat of plant species. Some of those environmental problems were the destruction of habitat, pollution, insufficient reproduction rate, disease, degree of specialization, growing water scarcity, desertification, preservation, and quality of forest, land/soil degradation, Global Climate change, Global Warming, Greenhouse effect, Acidification, Ozone depletion, and other local, regional and global level environmental problem [16].

Some works in the future to solve those environmental problems related to the threatened plant species are measuring and controlling pollution, study about endangered species, reforestation (restoration/reintroduction), education, recycling, and buying sustainable products and regulations [16].

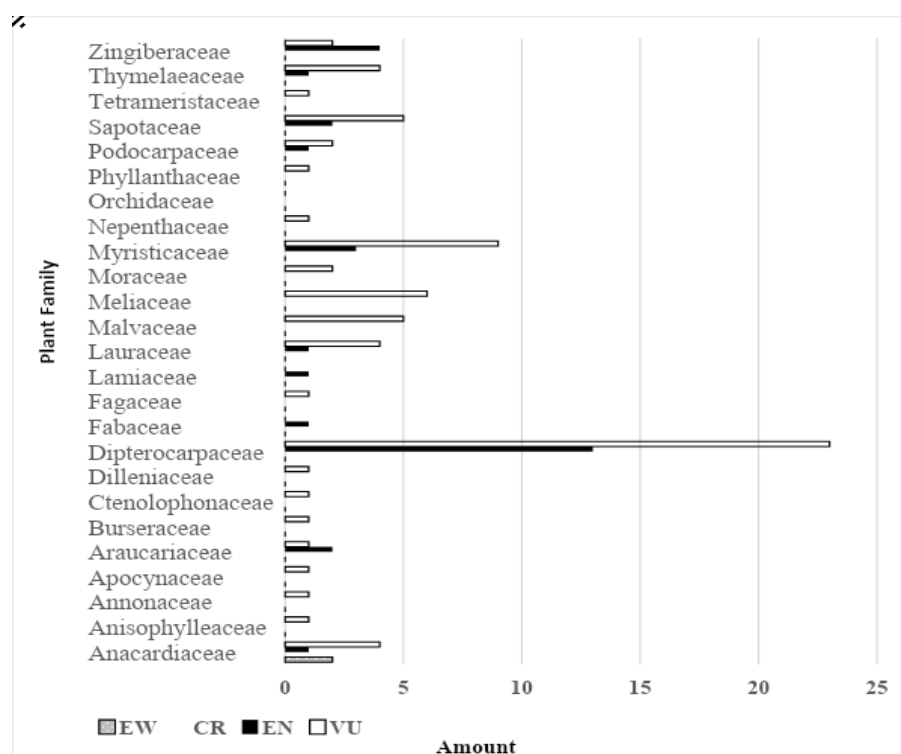


Figure 3. The amount of the threatened categories of the plant families distributed in Central Kalimantan

3.3. The potency of the threatened plants in Central Kalimantan

The threatened plant species including those from Central Kalimantan should be ex-situ conserved as soon as possible due to the extinction risk in their natural habitat, for instance as a collection in a Botanic Garden. The species collection could be then propagated and developed its potency. Most of the threatened plants distributed in Central Kalimantan namely 93 species (74.4 %) had potency as timber (major, minor or lesser-known commercial) [14, 17-21]. Many species of the member Dipterocarpaceae family have been known as a source of superior timber [14]. Moreover, there were also other threatened species of the other families that had utilization potency as timber, i.e. Anacardiaceae, Annonaceae, Apocynaceae, Araucariaceae, Burseraceae, Ctenolophonaceae, Dilleniaceae, Fabaceae, Fagaceae, Lauraceae, Malvaceae, Meliaceae, Podocarpaceae, Sapotaceae, Thymelaeaceae [14-15, 20-21]. On the other hand, at least 11 species had potency as food source/edible fruit, 29 species as medicinal plants, and 5 species as ornamental plants. The species of the family Anacardiaceae (*Mangifera*), Malvaceae (*Durio*), and Moraceae (*Artocarpus*) could be developed as a source of food (fresh fruit or processed fruit pulp) and for the breeding source material [20]. Furthermore, the species from the family Myristicaceae (*Horsfieldia*, *Knema*, *Myristica*), Meliaceae (*Aglaia*), and Zingiberaceae (*Alpinia*, *Etlingera*) [22-25] mostly had potency as medicinal plants. The genus *Horsfieldia* could have potency for diabetes mellitus medicine [23], whereas the genus *Knema*, which mostly produced anacardic acids and alkyl/acyl resorcinols exhibited cytotoxicity activity [24]. The genus *Etlingera* of the family Zingiberaceae had potency as an anti-microbial [25]. The species of the family Nepenthaceae and Orchidaceae could be developed as ornamental plants [26-27].

3.4. Distribution of threatened plant species in Central Kalimantan

From the total of 14 districts in Central Kalimantan provinces, twelve districts were known as the distribution of threatened plant species [11] (Figure 4). Those districts were Palangkaraya, Katingan, Barito Utara, Murung Raya, Barito Selatan, Kotawaringin Timur, Kotawaringin Barat, Kapuas, Gunung Mas, Lamandau, Seruyan, and Pulang Pisau. There were also 20 threatened species from 9 families, which were distributed in Central Kalimantan but their district's locations were not known. The number of plant families in each district ranged from 1 to 14, whereas those of the plant species ranged from 2 to 40 (Figure 4). The districts of Lamandau and Kotawaringin Barat had the lowest plant family number of one, on the other hand, Katingan and Kotawaringin Timur districts had the highest number of threatened plant families of 14 and 13, respectively (Figure 4). In regards to threatened plant species, the districts that had the lowest number (2 spp.) were Lamandau. On the other hand, the highest number of threatened plant species were Katingan district (40 spp.), followed by the districts of Kotawaringin Timur (37 spp.), Murung Raya (35 spp) and Barito Utara (29 spp.) (Figure 4).

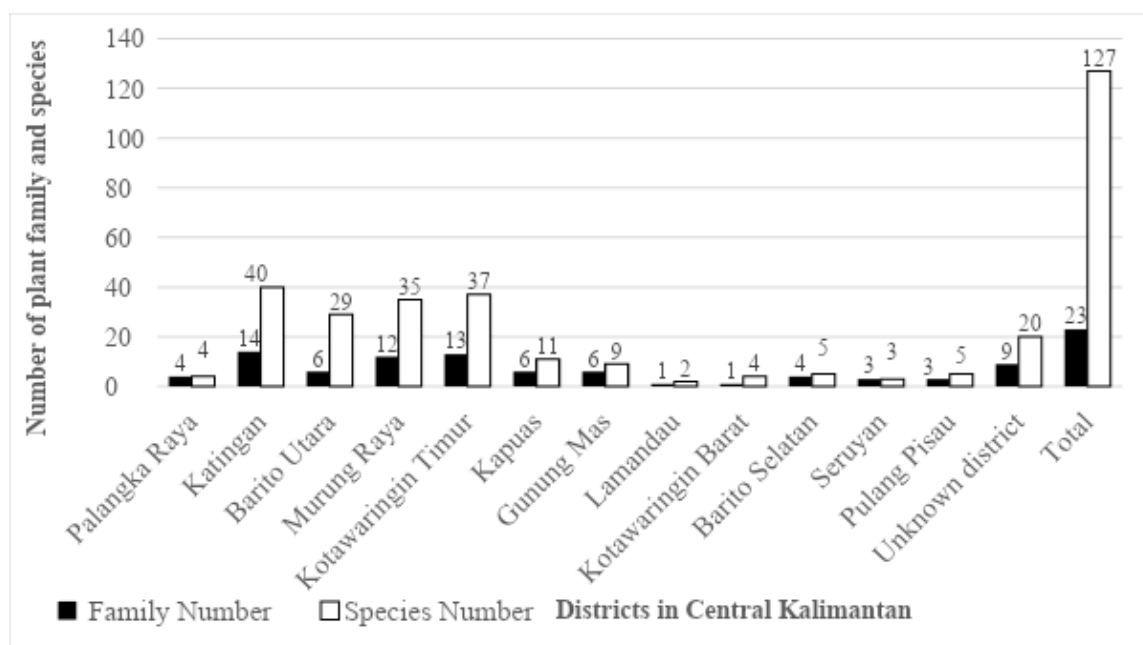


Figure 4. The amount of the family and the species of threatened plants distributed in the districts in Central Kalimantan

Each district of the threatened plant species distribution comprised 2 to 8 subdistricts (Figure 5). The lowest subdistrict was possessed by the districts of Seruyan (Seruyan Hulu and Seruyan Hilir), Kotawaringin Barat (Kumai, Kotawaringin Lama), and Lamandau (Belantikan Raya, Bulik) with 2 subdistricts (Figure 5). On the other hand, the highest number of subdistricts was Kapuas (Pasak Talawang, Damang Batu, Basarang, Kapuas Tengah, Timpah, Mantangai, Kapuas Hulu), Katingan (Senaman Mantikel, Bukit Raya, Petak Malai, Mendawai, Markit, Tumbang Habangoi, Tumbang Taranai) and Kotawaringin Timur (Mentawa Baru, Ketapang, Baamang, Telahga Antang, Antang Kalang, Bukit Santuai, Mentayan Hulu) with 7 subdistricts followed by Barito Utara (Teweh Tengah, Lahei, Montallat, Teweh Baru) and Murung Raya (Seribu Riam, Tanah Siang, Sungai Babuat, Tambelum) with 4 subdistricts (Figure 5). If we compared the number of species in each district and the number of subdistricts, then the district of Murung Raya possessed the highest average number of threatened species (8.75 spp.), followed by Barito Utara (7.25 spp.), Katingan (5.71 spp.), and Kotawaringin Timur (5.29 spp.).

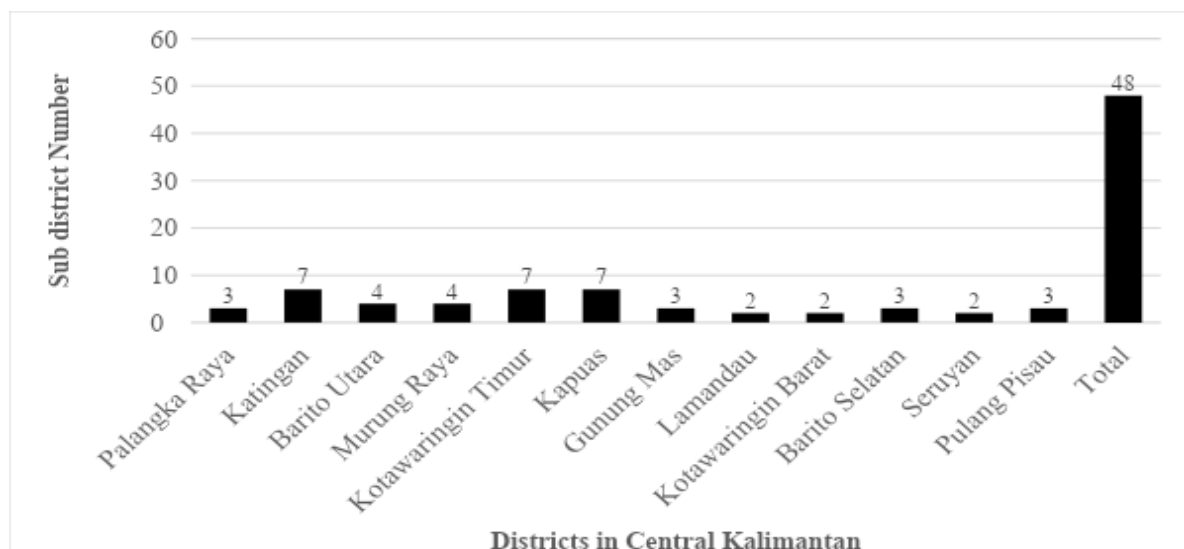


Figure 5. The number of subdistricts in the districts of Central Kalimantan as the location of the threatened plant distribution

Two species distributed in Central Kalimantan possessed the threatened status of extinction in the wild (EW) [4, 5]. The district in Central Kalimantan, which occupied the threatened plant species with the category critically endangered (CR) ranged from 0 to 5 species [4, 5]. The greatest number of that category was Barito Utara (5 spp), followed by Katingan (4 spp), Kotawaringin Timur (3 spp.), Murung Raya (3 spp.), and Kapuas (3 spp.) (Figure 6). The districts, which did not occupy CR status of threatened plant species were Palangka Raya, Gunung Mas, Lamandau, and Seruyan (Figure 6). On the other hand, the range of the plant species number in each district with Endangered (EN) status was from 0 to 12 spp. and those with Vulnerable (VU) status ranged from 1 to 24 spp. (Figure 6). The greatest number of the Endangered status was Katingan (12 spp), followed by Kotawaringin Timur (11 spp.), Barito Utara (9 spp.), and Murung Raya (8 spp.) (Figure 6). Whereas the district that possessed the most number with Vulnerable (VU) status was Katingan (24 spp.) and Murung Raya (24 spp.), followed by Kotawaringin Timur (23 spp.) and Barito Utara (15 spp.) (Figure 6).

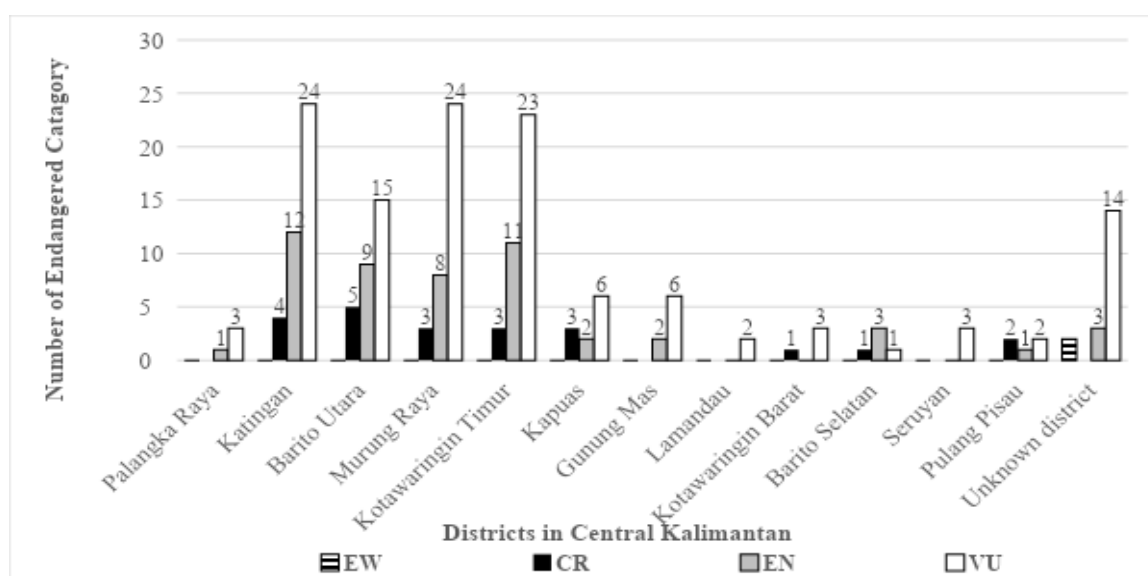


Figure 6. The number of threatened plant categories distributed in each district of Central Kalimantan. EW (Extinct in the Wild), CR (Critically Endangered), EN (Endangered), and VU (Vulnerable)

4. Conclusion

From the total of 860 threatened plant species in Indonesia, at least 125 species from 25 families were distributed in Central Kalimantan. The family with the greatest number of threatened plant species distributed in Central Kalimantan was Dipterocarpaceae (46 spp), and Myristicaceae (12 spp). Of the total of those threatened plant species, 2 spp were in the category Extinct in the Wild (EW), 16 spp Critical Endangered (CR), 30 spp Endangered (EN), and 77 spp Vulnerable (VU). About 93 species (74.4 %) of the threatened plant in Central Kalimantan had potency as timber. At least 11 species had potency as food source/edible fruit, 29 species as medicinal plants, and 5 species as ornamental plants. The greatest district that possessed the threatened plant species was Katingan (40 spp.), Kotawaringin Timur (37 spp.), Murung Raya (35 spp.), and Barito Utara (29 spp). Those threatened species should become the target to be collected for ex-situ conservation and further to be developed according to their utilization potencies.

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