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by Kissinger Kissinger

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SPATIAL DISTRIBUTION AND POTENTIAL OF METROXYLON SAGU ROTTB. FOREST IN SOUTH KALIMANTAN, INDONESIA

Kissinger*, Pitri, Rina Muhayah N.
Faculty of Forestry, University of Lambung Mangkurat Banjarbaru, South Kalimantan, Indonesia
*E-mail: durror2ali@gmail.com

ABSTRACT
Metroxylon sagu Rottb is a plant species of wetland that can produce carbohydrates. South Kalimantan is the 4th largest sago producer in Indonesia. Banjar district is one of the areas where covered by *M.sagu* forest. This study aims to analyze the spatial distribution and potential of *M.sagu* forest in Banjar district, South Kalimantan. The method of data collection was done by square plot. The 20 m x 20 m plots consist of at least 3 locations as samples of *M.sagu* forest. The 20 × 20 m quadrats were used to record trees with diameter=20 cm. The vegetation parameters measured were number of individuals, diameter and height. Spatial data was collected from secondary data. Spatial distribution of *M.sagu* forest analyzed by using ArcGIS software. The potential of sago forest is analyzed by calculating the diameter, height and volume of trees. The area covered by *M.sagu* forest in Banjar Regency is 401.62 ha. There are 2 subdistricts that have the largest *M.sagu* forest in Banjar district, namely Sungai Tabuk sub district and Astambul sub district. *M.sagu* forest area is 0.09% of the total area of Banjar district. The potential of *M.sagu* forest with a diameter > 20 cm is 119 trees/ha. The number of individual mature trees of *M.sagu* (diameter > 50 cm) reaches 48 stems/ha. The total potential production of wet starch from *M.sagu* forest in Banjar district is 3,855 tons. Banjar district is an area that has potential high *M.sagu* starch production in South Kalimantan.

KEY WORDS
Metroxylon sagu, spatial distribution, potential, Banjar district, wetland.

Wetland ecosystems contribute to (i) providing food, water, fiber, bioenergy, biochemical, and genetic resources, (ii) regulating hydrology, climate, erosion and pollination, (iii) supporting the development process of soil and nutrient formations, (iv) socio-cultural development (FAO. 2008). Inland wetland is a form of wetland ecosystem that has an important role in maintaining environmental balance.

The role of inland wetlands as food providers can be obtained from various species of plants and animals. An important form of food that can be provided by the inland wetland ecosystem is as a source of carbohydrates. *Metroxylon sagu*Rottb is known as an inland species plant of wetland that can grow naturally or be cultivated. *M.sagu* is a plant species that can produce carbohydrates.

The carbohydrate content of *M.sagu* starch is higher than rice (Bintoro. 2008). Starch from *M.sagu* can also be grouped as functional food (Alfonfs and Rivaie. 2011). *M.sagu* proved beneficial for health. The glycemic index is in the good category (Buyken*et al.* 2006). *M.sagu* can also be used as raw material for bioenergy (Syakir and Elna. 2013). *M.sagu* is easy to grow without complicated maintenance, its cultivation does not change the pattern of hydrological system in wetlands.

The Indonesian government's food development policy prioritizes sago as one of the leading cultivated foods. According to Presidential Regulation Number 18 of 2020 concerning the 2020-2024 RPJMN, Sago is included in 5 important plant commodities (coffee, cocoa, rubber, coconut and sago) for the development of the food industries.

M.sagu can be found in the tropics in Southeast Asia and the Oceania region (Bintoro*et al.* 2014). According to Nurlestari (2000), the area of *M.sagu* forest in Indonesia is around

1,111,280 ha. *M.sagu* productivity per hectare per year can reach 18 tons of wet starch of sago, so that the potential for *M.sagu* starch production in Indonesia is 20 million tons/ year.

South Kalimantan is one of place that producing starch of*M.sagu.* South Kalimantan is the 4th largest sago producer in Indonesia after Riau, Maluku and Papua. The area of *M.sagu* forestin South Kalimantan Province is relatively wide reaching 7,857 hectares with production was 4,511 tons in 2017. *M.sagu* is widely available in Banjar, Tapin, and Barito Kuala Regencies (Wahyuningtyas*et al.* 2018). According to the field observation, the others area in South Kalimantan covered by *M.sagu* forest are Hulu Sungai Utara district, Hulu Sungai Selatan district and Hulu Sungai Tengah district. Sago starch production tends to decline to 3,724 tons in 2021 (Indonesia Ministry of Agriculture. 2020)

M.sagu is an important commodity because the area of South Kalimantan has many wetland areas that allow sago to grow well. Banjar Regency is known to have the largest *M.sagu* area in South Kalimantan, but the distribution of *M.sagu* forest have not been accurately identified and documented. This study aims to analyze the spatial distribution and potential of *M.sagu* forest in Banjar district, South Kalimantan. This research is important as an effort to develop *M.sagu* forest as a potential food source for the community.

METHODS OF RESEARCH

The research was conducted in the Banjar district, South Kalimantan, Indonesia. Geographically, it is located at the coordinates between 2°49'55" - 3°43'38" South Latitude and 114°30'20" - 11°533'37" East Longitude. The research object used is the *M.sagu* forest area located in the Banjar Regency, South Kalimantan. Description of the *M.sagu* forest in Banjar district is shown in the figure 2. The research tools used are:

- A set of terrestrial survey equipment (phi band for measuring diameter, laser meter for measuring height, GPS, tally sheet, camera for documentation);
- A set of data processing equipment (a set of computers, printers, thematic layers, Arc GIS software for geospatial data processing and Microsoft Excel software for data analysis).

The data collection procedure carried out is as follows:

- *M.sagu* forest vegetation. Determination of the plot sampling to measuredt vegetation parameter of *M.sagu* was carried out by purposive sampling. The method of data collection was done by square plot. The 20 m x 20 m plots consist of at least 3 locations as samples of *M.sagu* forest. The 20 × 20 m quadrats were used to record trees with DBH (Diameter at Breast Height) 20 cm. The vegetation parameters measured were number of individuals, diameter and height;
- Geospatial data collection. Spatial data was collected from secondary data such as the Geospatial Information Agency, the Forestry Service, Geospatial Information Laboratory, Faculty of Forestry, ULM and reference review. Data collection was carried out including composite image data from Google Earth services, area function maps, administrative maps and road network maps and river maps.

Spatial distribution of M.sagu forest consist of:

- Composite image processing. Image interpretation was done visually (on screen digitization) of the composite image to classify land cover of *M.sagu* forest and non *M.sagu* forest. Classification was carried out based on differences shown by elements of image interpretation such as color (tone), shape, pattern, texture, and association. The classification of vegetation cover obtained is *M.sagu* forest area and non *M.sagu* forest area. Image processing was done by using Arc Gis software;
- Percentage of interpretation accuracy. Sample points were spread over several areas which were interpreted based on composite image analysis as *M.sagu* forest and non*M.sagu* forest. The method of determining the sample point for interpretation testing was done purposively. There were 50 sample points for testing the interpretation results of the classification of sago forest and non-sago forest. Percentage of interpretation accuracy was calculated by using following formula:

Percentage of accuracy= (interpretation value/observed value) x 100%

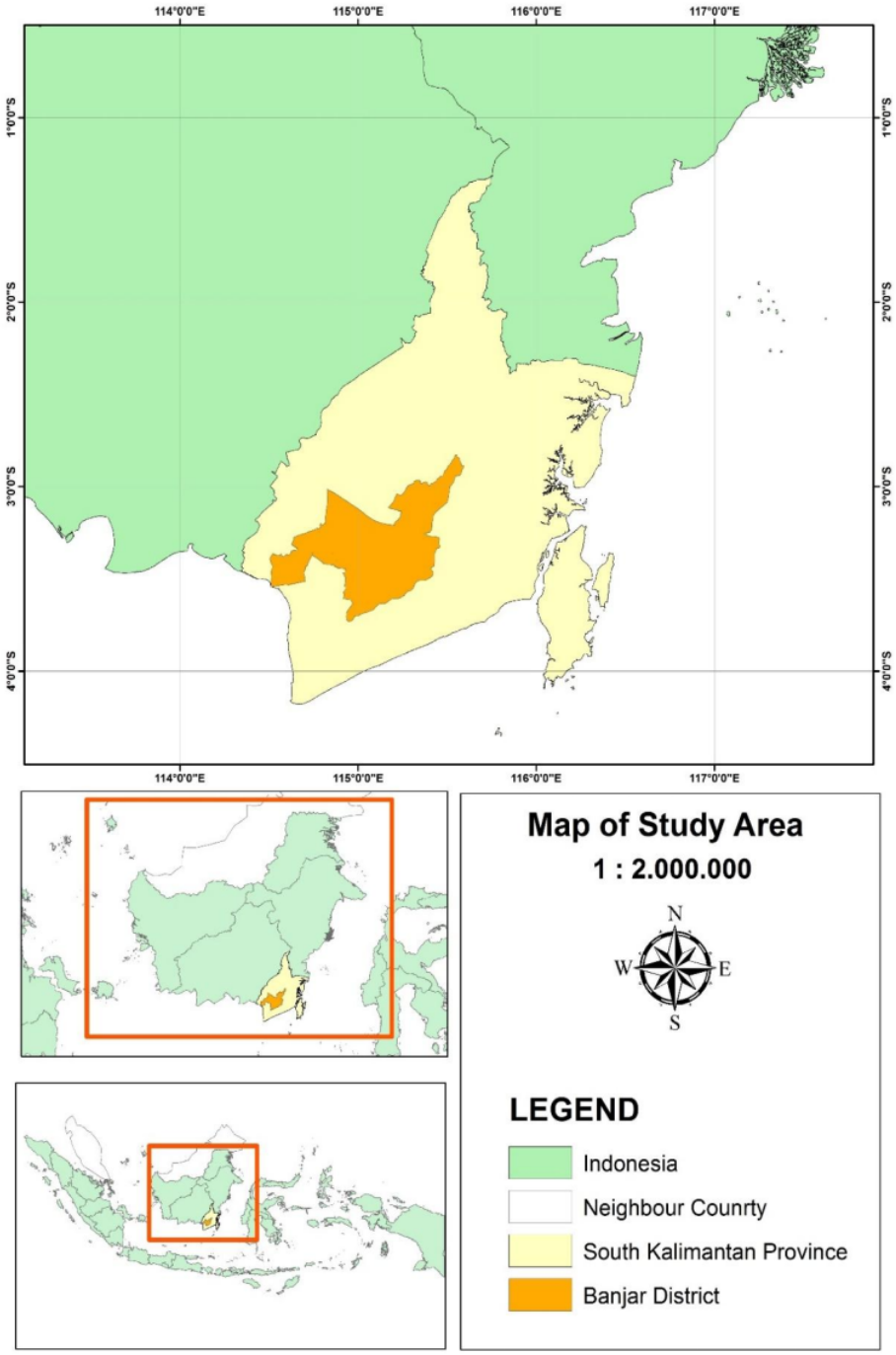

Figure 1 – The location of research area

Figure 2 – Description of *M.sagu* in the field

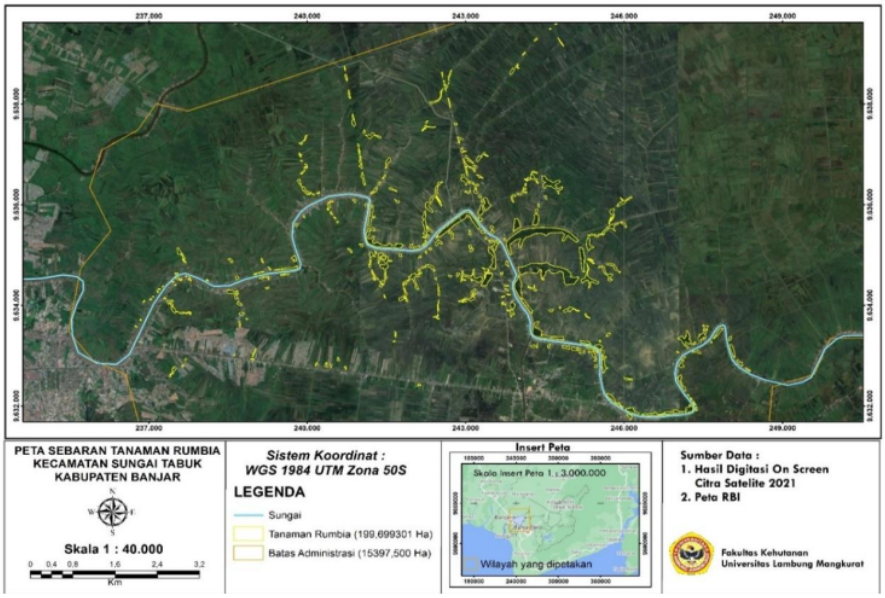

Figure 3 – Spatial distribution of *M.sagu* forest in Sungai Tabuk subdistrict

The potential of M.sagu forest. There were 12 square plots measuring 20 m x 20 m made to measure vegetation data. The potential of sago forest is analyzed by calculating the diameter, height and volume of trees. The average height and diameter of the plant was calculated by using the following formula:

$$\bar{d} = \sum_{i=1}^{n} d_i/n \; \bar{t} = \sum_{i=1}^{n} t_i/n$$

Where: d = diameter (cm); t = height (m); di/ti= diameter and height of tree to-I; n = number of trees sample.

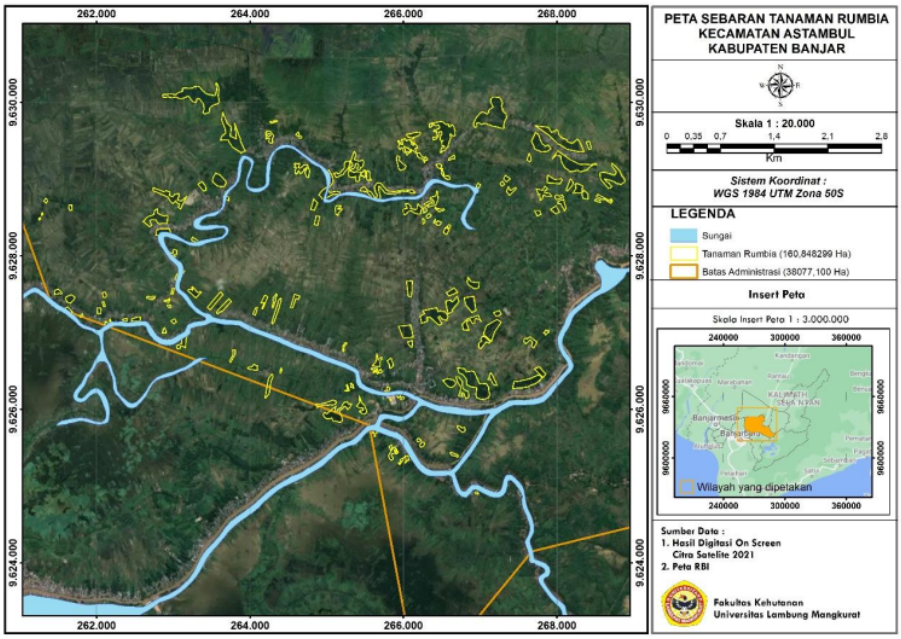

Figure 4 – Spatial distribution of *M.sagu* forest in Astambul subdistrict

The volume of the M.sagu trees was calculated by the following formula approach:

$$V = ¼.\pi.d2.h.f$$

Where: V= Volume of tree; π = 3,14; d = Diameter breast height (1,3 m); h = Tree height; f = Correction factor (0,7).

The result of analysis average potential of *M.sagu* forest/ha then converted to the total area covered by *M.sagu* forest. The calculation results are presented in a tabulation matrix.

RESULTS AND DISCUSSION

The distribution of *M.sagu* forest is administratively spread over 7 sub-districts. The distribution of *M.sagu* forest based on administrative area in Banjar District is listed in Table 1.

Table 1 – Distribution of *M.sagu* in Banjar district South Kalimantan

Nu	Location	Administrative area (ha)	*M.sagu* forest area [ha]
1	AluhAluh sub district	8284	0.82
2	Gambut sub district	12930	1.76
3	Sungai Tabuk sub district	14730	199.70
4	Martapura sub district	22140	34.88
5	Karangintan sub district	21535	3.32
6	Astambul sub district	21650	160.85
7	SimpangEmpat sub district	14180	0.30
	TOTAL	115449	401.62

There are 2 subdistricts that have the largest *M.sagu* forest area, namely Sungai Tabuk sub district and Astambul sub district. Based on the comparison with the area of Banjar district, the percentage of *M.sagu* forest area is 0.09% of the total area of Banjar district (466,850 ha). This percentage is quite small. M.sagu forest habitat is mostly on rivarian land.

Hariyanto (2011) stated that M. sago habitats are generally located in swampy areas and around rivers (rivarian).

The accuracy of interpretation in classifying *M.sagu* forest can be seen in Table 2.

Table 2 – Percentage of interpretation accuracy

n/n	*M.sagu* Forest	Non *M.sagu* Forest
Interpretation	25 plot	25 plot
Observed	24 plot	25 plot
Percentage of accuracy	96%	100%
Mean of accuracy	-	98.0%

The accuracy of interpretation reaches 98%. Several factors that cause the high accuracy of interpretation are: the color (tone) of *M.sagu* is very clearly identified in the composite image. The color of *M.sagu* looks dark green, the shape of *M.sagu* is also relatively clear with a crown shape that can be distinguished from other palm trees such as *Cocos nucifera* and *Elaisguinensis*. The pattern of *M.sagu* forest is generally clustered with coarse texture as a result of the formed canopy stratification. The indicator of association of *M.sagu* with rivers is also a guide in accurate interpretation. Inaccuracy of interpretation related to changes in land use from *M.sagu* forest to residential areas. The form of land use change in sago forest generally turns into residential areas or rice fields.

The spatial distribution pattern of *M.sagu* forest in the 2 subdistrict areas with the largest area is shown in Figure 2 and Figure 3.

M.sagu found in the research location grows on the borders of large rivers and some small rivers. The characteristics of the place where *M.sagu* grows in South Kalimantan are on alluvial soil andassociated with rivers or creeks. Hermawan (2010) stated that one type of soil where *M.sagu* grows is alluvial soil. Some *M.sagu* patches grow in basins that are flooded with water. The *M.sagu* forest patches in these inundated areas are usually adjacent to rice fields and irrigation canals.

The two sub-districts that have a large number of *M.sagu* are geographically located side by side and are located along a large river (Sungai Martapura). The Martapura River is included in the sub watersheet of the Barito Watersheet. The Barito River is the largest and longest watersheet in South Kalimantan Province.

The potential of M.sagu forest. The calculation of the potential of*M.sagu* forest is limited to trees > 20 cm in diameter. The results of the analysis of the potential of *M.sagu* forest in Banjar district are listed in Table 3.

Table 3 – The potential of *M.sagu* forest in Banjar district South Kalimantan

No	The Potential Vegetation of *M.sagu* Forest	Value
1	Range of diameter	21.2 - 58.2 cm
2	Mean of diameter	39.18 cm
3	Range of height	5 - 25 m
4	Mean of height	14.18 m
5	Number of trees/ha (diameter> 20 cm)	119 trees
6	Total volume/ha	3.42 m3
7	Coverage area of *M.sagu* forest	401.62 ha
Total volume of *M.sagu* in Banjar district		1372.87 m3

The potential of *M.sagu* forest is quite large. The potential for *M.sagu* forest with a diameter > 20 cm is 119 trees/ha. *M.sagu* that is cut down for starch production has a diameter of > 50 cm (mature tree). The number of individual mature trees of *M.sagu* in Banjar district reaches 48 stems/ha. According to information from several home industries of *M.sagu* starch in Banjar district, one mature tree of *M.sagu* can produce 200 kg of wet *M.sagu* starch. Thus, the total production of wet starch from *M.sagu* forest in Banjar district is 3,855 tons. This result is greater than the prediction of *M.sagu* production in 2021 throughout South Kalimantan with a production volume of 3,724 tons (Indonesian Ministry of Agriculture. 2020). These results illustrate that *M.sagu* production in South Kalimantan can be further

increased, because the distribution areas of *M.sagu* in other districts such as Tapin, Hulu Sungai Tengah, Hulu Sungai Utara, Hulu Sungai Selatan and Barito Kuala, have not been taken into account.

CONCLUSION

The spatial distribution of *M.sagu* forest is spread over 7 sub-districts. The area covered by *M.sagu* forest in Banjar Regency is 401.62 ha. There are 2 subdistricts that have the largest *M.sagu* forest area in Banjar district, namely Sungai Tabuk sub district and Astambul sub district. *M.sagu* found in the research location grows on the borders of large rivers and some small rivers. The percentage of *M.sagu* forest area is 0.09% of the total area of Banjar district (466,850 ha).The potential of *M.sagu* forest with a diameter > 20 cm is 119 trees/ha. *M.sagu* tree that is cutting down for starch production has a diameter > 50 cm (mature tree). The number of individual mature trees of *M.sagu* in Banjar district reaches 48 stems/ha. The total potential production of wet starch from *M.sagu* forest in Banjar district is 3,855 tons. The results of this research indicated that the production of *M.sagu* forests can be increased to improve the welfare of the community.

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