The potential of sago as a local food ingredient to support the food security in South Konawe

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Abstract. Southeast Sulawesi is one of Indonesia's regions with several specific plants, including the sago plant. Sago is a portion of typical food for people in Southeast Sulawesi, especially in mainland areas such as Konawe, South Konawe, North Konawe, Kolaka, and East Kolaka. In Southeast Sulawesi, the sago plantation area has decreased sharply from the original site of 13,706 hectares to around 5,912 hectares. The depreciation of the sago planting area is thought to have been caused by converting land use from sago to rice fields, settlements, and other benefits. Although sago has many uses and advantages and can support food security, it faces severe problems in its cultivation due to narrowing the sago planting area and decreasing its production potential. This study aimed to identify the distribution of the potential regions for sago growth in the South Konawe Regency through spatial analysis techniques for land cover using Landsat-8 satellite imagery. From the results of spatial analysis, it was found that there was a potential sago plantation area to be developed in South Konawe Regency, which reached 5,873 ha. The largest site of sago was in North Moramo, Benua, Anggata, and Andolo Barat Districts. This area was the main center for sago processing in Konawe Selatan Regency.

1. Introduction
With the Latin name Metroxylon sago Rottb, this sago plant is one of the monocot plants from the Palmae or Arecaceae class. Sago plants can thrive in forests or swampy areas. Although this condition has its ecological advantages, it is not economically profitable because it will complicate its distribution route. Sago can be used as a carbohydrate food source, especially for some eastern Indonesia residents who make it a staple food, namely people in Maluku, Sulawesi, and Papua. Sago is consumed as a side dish, either in the form of sago plates, sinaí, bagea, etc. which are generally produced in small-scale industries and households. Sago is also used as a composite for flour substitution. Sago plants can act as environmental protection because they can absorb carbon dioxide gas emissions from swamps and peatlands into the air [1], while sago waste can be used as bio-ethanol [2]. Sago starch also has great potential and prospects as industrial raw materials such as acetone-butanol-ethanol fermentation substrates [3], raw materials for making degradable plastics [4,5], sugar industry liquid [6], and food flavoring [7], even used for new energy sources in the form of bioethanol [8].
Sago palms can grow up to 20 to 30 m tall. One tree can produce 150 to 300 kg of starch. The composition of sago plants consists of 78.34% water content, 0.20% fat, 1.31% protein, 6.67% carbohydrates, 13.48% crude fiber, and 0.65 g sago fiber density/cm³ [9]. Sago can become a national food production center that can reduce the level of dependence on imported materials. Sago can also be a solution to food security in Indonesia and even the world. Sago can be an alternative food substitute for rice and sugar because it can be a source of healthy local food raw materials. Good sago management can strengthen the role of rice and sugar diversification in the community.

According to the Southeast Sulawesi Provincial Industry Office, sago cultivation in Southeast Sulawesi in 1985 reached 13,706 ha, but this area continued to decline due to the conversion of sago land to rice fields, plantations, or settlements. From the 2014 Southeast Sulawesi BPS data, the area of sago planted at that time reached 5,912 ha, about 65.0% (3,830 ha) of which were productive sago, while 32.5% (1,925 ha) were unproductive sago and the remaining 2.66% or 157 ha are unproductive sago. The reduction in sago land is also caused by sago cultivation, which is still extractive, where farmers only harvest without any effort to replant. If allowed to continue, this situation can lead to the extinction of the sago plant. Efforts to conserve sago palms are planned and targeted cultivation of sago palms, so it is deemed necessary to conduct research to determine potential locations for the development of sago cultivation.

2. Methodology

2.1. Study area
This research was conducted in South Konawe Regency, Southeast Sulawesi Province, from October to December 2019. This area consists of 25 sub-districts.

2.2. Tools and materials
The tools used in this research included a digital camera, Garmin GPS, Global Mapper, ESRI ArcGIS 10.1 and ERDAS ER Mapper 9.1, and a set of DELL laptop Core i7 RAM 8GB. The materials used in this research included Ground Control Point (GCP); Landsat-8 raw data full band 15m resolution in panchromatic and 30m resolution in multispectral recorded in the year 2019, in path 112 row 63 and GeoTIFF format; thematic data such as road, river, and coastline in shapefile format obtained from Geospatial Information Agency of Indonesia; and literature.

2.3. Research procedures
2.3.1. Initial processing of satellite imagery. This step included radiometric correction, geometric correction, composites, fusion, and sharpening image contrast. Histogram adjustment method used in radiometric correction, and the nearest neighbor method used in rectification process.

2.3.2. Colour composite. The color composite used in image analysis was the original true-color composite RGB channel 321 and false-color composite RGB channel 432. Pan sharpened image process conducted on Landsat-8 multispectral channel satellite imagery. The fusion process was carried out to improve the quality of the visual display of imagery. Contrast enhancement is used to increase the contrast difference between objects on the mainland, coastal, and waters. Linear Transformation Method with the auto clip of 99% used for contrast enhancement process.

2.3.3. Landcover mapping. Landcover data generated through the processing of Landsat-8 satellite imagery and field survey. Supervised classification digital feature extraction method used for landcover classification mapping. Classes of landcover mapped in this research were forest, crop, mangrove, settlement, bush, aquaculture-ponds, open land, farm-field, and sago. Sago vegetation was the focal point in this study.
2.3.4. Survey. Field verification aimed to correct the results of remote sensing data processing carried out in the laboratory. Field verification was done by the number of survey points (GCP) that correspond to the field conditions using the purposive sampling method.

2.3.5. Accuracy assessment. Accuracy assessment aimed to measure the validity of the thematic layer data to be accepted as an input parameter in the preparation of the model, which was delivered from the land cover map. Accuracy-test of the land cover map resulted from image processing compared with the factual data in the field through a set of GCPs.

2.3.6. Assessment of sago vegetation using NDVI. Normalized Different Vegetation Index (NDVI) was used to measure the vegetation density index. NDVI values range from -1 to 1. Value of -1 indicates the lowest level of vegetation density, and a value of 1 indicates the highest level of vegetation density.

3. Results
Sago plants in Southeast Sulawesi generally grew and developed naturally on dry, rainfed lands that are periodically flooded and permanently inundated or in swamps on the banks of rivers. Generally, the sago palm has not been appropriately cultivated. The community or sago farmers usually only harvest extractive, and there has been no attempt to replant. This condition causes the area of sago plants to continue to decline.

The preliminary research results indicated that the sago plantation area in South Konawe Regency reached 5,873 ha (table 1). The largest area of sago was in North Moramo, Benua, Anggata, and Andolo Barat Sub-Districts. This area was the main center for sago processing in South Konawe Regency.

| District         | Area (ha) | Percentage (%) |
|------------------|-----------|----------------|
| Andoolo          | 333.65    | 5.68           |
| Andoolo barat    | 881.48    | 15.01          |
| Anggata          | 29.80     | 0.51           |
| Basala           | 1,225.25  | 20.86          |
| Benua            | 61.57     | 1.05           |
| Buke             | 229.71    | 3.91           |
| Laeya            | 194.98    | 3.32           |
| Lalembuu         | 563.94    | 9.60           |
| Lainti           | 92.54     | 1.58           |
| Moramo           | 1,315.47  | 22.40          |
| Mowila           | 281.32    | 4.79           |
| Palangga         | 26.51     | 0.45           |
| Palangga selatan| 427.18    | 7.27           |
| Ranomeeto        | 209.60    | 3.57           |
| Wolasi           | 5,873.00  | 100.00         |

Table 1. Sago plantation area in South Konawe Regency.
The distribution of sago areas in several sub-districts in the South Konawe Regency can be seen in figure 1.

![Map of sago vegetation distribution in South Konawe Regency](image)

**Figure 1.** Map of sago vegetation distribution in South Konawe Regency.

From the analysis of the density level of sago vegetation using the NDVI method, the distribution of sago density index values in South Konawe Regency was generally in a moderate to high condition, which was indicated by a yellow to reddish hue (figure 2). This result showed that sago vegetation cover in the South Konawe Regency was still quite right. The potential for development was expected to be very good, and a sustainable sago management strategy design can be made, considering that the sago planting area in South Konawe Regency was quite large.
Figure 2. Map of sago density index in South Konawe Regency.

4. Conclusions
The area of sago in South Konawe Regency reached 5,873 ha, with the main planting center located in Moramo District covering an area of 1,315.47 ha (22.45%), Benua District covering an area of 1,225 ha (20.86%), and Angata District covering an area of 881.48 ha (15.01%), with index. The density of the sago plant was generally moderate to high.

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