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SPATIAL MAPPING OF COCONUT PLANTATION IN MINAHASA REGENCY, NORTH SULAWESI PROVINCE USING REMOTE SENSING DATA

Pemetaan Spasial Perkebunan Kelapa di Kabupaten Minahasa, Provinsi Sulawesi Utara Menggunakan Data *Remote Sensing*

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Abstract

The production of coconut/copra in Minahasa Regency in 2019 was 21,350 tons with an area of 18,240 Ha. The area of coconut plantations in Minahasa Regency in 2018 was 18,470 Ha (Central Bureau of Statistics Minahasa Regency in Figures, 2020). There was a decrease in the area of coconut plantations in Minahasa Regency by 230 ha. This research was conducted in Minahasa Regency, North Sulawesi Province in April-October 2021. This study aims to interpret the SPOT 6 2019 satellite imagery of Minahasa Regency using a visual interpretation method using ArGIS Software. Image interpretation with visual techniques is the division of land cover classes by direct delineation on satellite images according to the pattern, hue and compactness of pixels in the image. The results of visual interpretation of satellite images show coconut plantations in Kab. Minahasa is 19,622 Ha. Coconut plantations are spread across all sub-districts in Minahasa Regency. The largest coconut plantation area is in Tombulu Regency (6,635.58 Ha) followed by Mandolang Regency (2,807.35 Ha) and Tombariri Regency (2,147.57 Ha). The smallest coconut plantation area in Minahasa Regency is in East Tondano District (0.16 Ha) followed by North Tondano District (1.56 Ha) and Kawangkoan District (5.35 Ha).

Keywords: *Visual interpretation, plantation, satellite imagery*

INTRODUCTION

Coconut is one of the plantation commodities that has an important role in the national economy with the main product being copra. All parts of the plant can be utilized so that the count plant is known as the Tree of Life. In addition, coconut is a social crop because +98% is cultivated by farmers. In the midst of the Covid pandemic, coconut is one of the prima donnas of agriculture with VCO (Virgin Coconut Oil) products which are claimed to be able to kill the Coronavirus.

The development of coconut plants must continue to be pursued because this commodity has several comparative and competitive advantages, which are not found in other palm trees. Apart from being a source of food, this commodity is a source of renewable energy. Some of the main coconut products cannot be replaced by competing plant products, including palm oil. These products are coconut milk, desiccated coconut, coconut sap, and coir.

Plantation production is not only a provider of raw materials for the processing industry but also for environmental conservation (protective plants). Coconut as a plantation commodity has a fairly high economic value, so it is more sought after by the community. Intercropping or integration of coconut plants with other commodities is one solution. Farmers earn other income on land that is cultivated for coconut plantations. This effort may not directly increase the income from coconut plantations. Integration of coconut with other commodities can increase land productivity. However, research has shown that coconut plantations that are integrated with other commodities are able to increase the productivity of coconut plants.

In North Sulawesi, the area of coconut plantations in 2019 was 265,300 Ha. In 2018, the area of coconut plantations in Nyiur

Melambai province was 263,510 thousand hectares. There was an increase in the area of coconut plantations by 1790 Ha. For the District. Minahasa, coconut plantation area is 18,240 Ha in 2019 and 18,470 Ha in 2018 (North Sulawesi Central Bureau of Statistics data). There was a decrease in the area of coconut plantations in the Minahasa district by 230 ha. The decrease in the coconut area is thought to be due to the conversion of agricultural land to settlements, especially in plantation areas bordering the city of Manado (Rotinsulu, 2018).

Food security is one of the priorities or superior research fields of Sam Ratulangi University. Research is one of the research topics contained in the Research Road Map in the Research Master Plan of Sam Ratulangi University. This research will contribute to the achievement of the NUSRAT research roadmap that will contribute to agricultural development in North Sulawesi Province, especially in the Minahasa Regency. Up-to-date land cover information is needed for policymakers or relevant stakeholders for sustainable land resource management. The general method used to obtain land cover information is field surveys and using remote sensing data and Geographic Information System (GIS) technology.

Problems faced with monitoring changes based on field surveys are the size of the study area, the length of time and the cost of the survey. As a result, the monitoring carried out is not effective because it cannot keep up with the rate of land cover change, especially in the tropics. Remote sensing technology provides up-to-date, quality, efficient and relatively inexpensive land cover data and with a wide area coverage for an effective inventory and monitoring of land cover changes (Jensen, 1996). The Food and Agriculture Organization (FAO) has adopted remote sensing technology in conducting Forest Resources Assessments since the 1990s (FAO, 2007b). Remote sensing and GIS data have been used to monitor land cover changes in the Tondano watershed area of North Sulawesi (Rotinsulu, et al. 2018).

This study aims to interpret satellite images (current year 2019) using the visual interpretation method using ArcGIS software. The results of image interpretation will then be used for spatial mapping of coconut plantations in the Minahasa Regency. The results of the spatial mapping will be used for future land use planning for coconut plantations.

MATERIAL AND METHODS

Remote Sensing Data

The remote sensing data used is SPOT image data for 2019. The SPOT (Satellites Pour observation de la Terre) satellite is a constellation satellite used for earth observation. Together with SPOT 1 and SPOT 3, the SPOT 2 Satellite is a French satellite in cooperation with Belgium and Sweden. Each SPOT series provides two identical high-resolution optical imaging instruments namely panchromatic (P) and Multispectral (XS: Green, Red, and Near Infrared). SPOT-6 has a resolution of 1.5 meters Panchromatic and 8 meters multispectral (Blue, Green, Red, Near-IR).

Ground Reference Data

For visual interpretation of coconut plantations, the survey carried out was to take the real conditions of coconut plantations in the field in several locations of coconut plantations spread across the Minahasa regency. Location data is recorded using the Global Positioning System (GPS). In addition, visual observations were recorded using a digital camera. Field documentation is presented in the following figure. To collect field data, tools and materials are needed, including maps of the earth, GPS, digital cameras, writing instruments, compasses, and batteries. The research procedure in the form of a flow chart can be seen in Figure 1.

Image Interpretation Data Analysis

Classification is the process of grouping pixels into classes/groups that have homogeneous spectral characteristics (Campbell, 2002). Image classification using remote sensing software and GIS (ArcGIS). Image classification is a method for dividing each pixel in a digital image into several classes. The land cover study uses image classification methods to divide land cover classes that can represent land cover conditions on the earth's surface. Image classification techniques are divided into three

namely automatic, semi-automatic and manual classification.

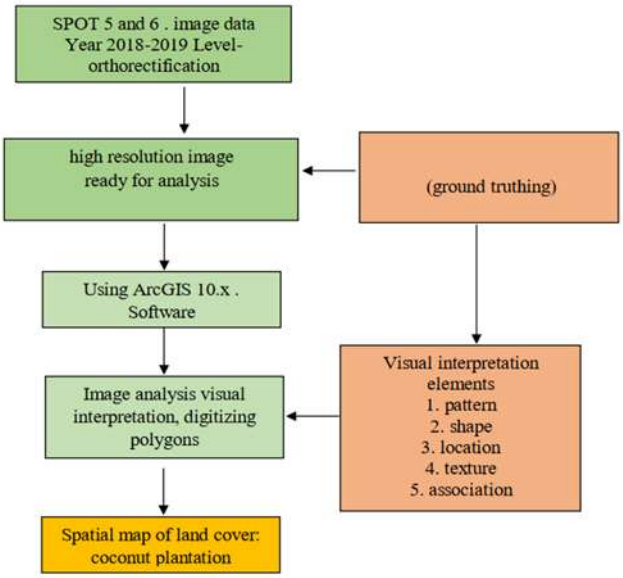

Figure 1. Research Flowchart

Figure 2. SPOT image of Minahasa Regency in 2019

RESULTS AND DISCUSSION

Visual interpretation of satellite images

Visual interpretation of satellite imagery has produced a map of the distribution of coconut plantations in Kab. Minahasa spatially (Figure 5 and Figure 6). Visual interpretation of coconut plantation land is based on several elements, namely:

1. Pattern. The pattern is a series of geological forms, topography, vegetation, or other earth surface phenomena. Coconut plantations have a specific pattern, planted with a certain spacing so that it can be seen from the image that the pattern is lined up (Figure 3).
2. Shape is a qualitative measure of the length, width, and height of an object. Interpretation of form provides important information related to the type, quality, and quantity of singular or plural objects. Coconut plantations can be seen from the specific canopy shape in the image as shown in Figure 3 below.
3. Location is the position of the object in a certain coordinate or the location of an object

compared to other objects. Object location information is very useful in interpretation. Coconut plantations are located in various locations in Minahasa Regency. By taking coordinates through a field survey, it is easier to interpret the image.

4. Texture is the roughness or smoothness of the visualization of the surface of the object in the image. Coarse texture indicates heterogeneity in the crowd of objects on earth. The interpretation of a vegetation cover with a coarse texture provides clues to variations in the type and size of the vegetation. This condition allows a more detailed interpretation of the vegetation cover, for example as dense forest or mixed gardens (Figure 5).

5. Association is the relationship of a phenomenon with other phenomena around it. Expanded objects with fine textures associated with the presence of several road networks and settlements, can provide interpretive information that leads to cultivated areas or gardens (Figure 4 and Figure 5).

Table 1 shows the results of visual interpretation of satellite images showing coconut plantations in coconuts in Minahasa regency 18,351.52 Ha. Coconut plantations are spread across all sub-districts in Minahasa Regency. The area of the largest coconut plantation in the district. Tombulu (6,635.58 Ha), followed by Mandolang district (2,807.35 Ha) and Tombariri district (2,147.57 Ha). The smallest coconut plantation area is in East Tondano district (0.16 Ha), followed by North Tondano district (1.56 Ha) and Kawangkoan district (5.35 Ha). Spatial map of coconut plantations in Minahasa regency is presented in Figures 4, 5 and 6.

Figure 3. Image display of coconut plantations in Minahasa regency (certain patterns and unique canopy shapes)

Figure 4. The condition of coconut plantations in the field as shown in the image Figure 3

Figure 5. Image display of coconut plantations in Minahasa regency (Tombulu district) association with settlements, roads, and rivers)

Figure 6. Image display of coconut plantations in Minahasa regency (Mandolang district) association with settlements, roads

Table 1. Area of coconut plantations in Minahasa Regency visual interpretation results

District Name	Area (HA)
Eris	24.47
Kakas	646.66
West Kakas	689.41
Kawangkoan	5.35
West Kawangkoan	7.31
North Kawangkoan	30.22
Kombi	1,240.55
West Langowan	7.90
South Langowan	1,183.82
East Langowan	6.87
North Langowan	23.95
East Lembean	921.17
Mandolang	2,807.35
Pineleng	1,005.10
Remboken	7.16
Sonder	339.16
Tombariri	2,147.57
East Tombariri	594.23
Tombulu	6,635.58
South Tondano	25.97
East Tondano	0.16
North Tondano	1.56
TOTAL	**18,351.52**

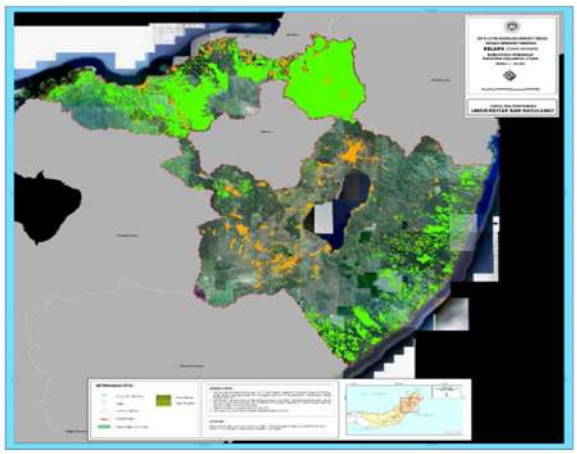

Figure 7. Map of spatial distribution of coconut plantations in Minahasa regency

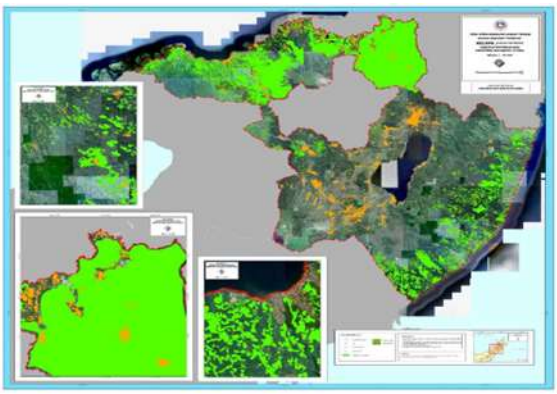

Figure 8. Map of the spatial distribution of coconut plantations in Minahasa Regency with field documentation inset

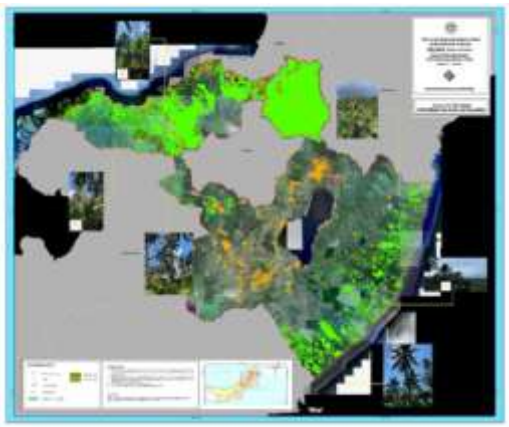

Figure 9. Map of the spatial distribution of coconut plantations in Minahasa Regency with inset several locus of coconut distribution

The area of coconut plantations as a result of image interpretation 2 totals 18,351.52 Ha (Table 1) The area of coconut plantations through visual image interpretation shows 110.48 Ha wider than the 2019 Compared to 2018 of 18,470 Ha, the area of coconut plantations in 2019 has decreased by around 119 Ha (visual interpretation results) or 230 Ha (North Sulawesi Central Bureau of Statistics data).

The decline in the area of coconut plantations in North Sulawesi, especially in Minahasa Regency, is thought to be due to the conversion of coconut plantation land to residential or industrial areas. The results of research conducted by Rotinsulu, et al (2018) in the Tondano watershed area which includes Minahasa Regency, North Minahasa Regency and Manado City show that within a period of 13 years (2002-2015) there was conversion of

forest land to agriculture, and agriculture to urban areas. settlement. Conversion of agricultural land to settlements, especially in areas bordering Manado City with the development of residential/housing land.

CONCLUSION

1. Spatial map of the distribution of coconut plantations Minahasa regency can be produced through visual interpretation of images by using elements of pattern, shape, association and texture interpretation.
2. Coconut plantations are spread across all sub-districts in Minahasa Regency. The area of the largest coconut plantation in the Tombulu district (6,635.58 Ha), followed by the Mandolang district (2,807.35 Ha) and Tombariri district (2,147.57 Ha). The smallest coconut plantation area is in East Tondano district (0.16 Ha), followed by North Tondano district (1.56 Ha) and Kawangkoan district (5.35 Ha).

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