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Geographic Information System for Mapping the Area and Coconut Production in Kendal Regency

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Abstract

Coconut fruit holds high economic value as it can be utilized for various products and significantly contributes to the local economy. This research aims to develop a Geographic Information System (GIS) to map land area and coconut production in Kendal Regency in 2023 as a foundation for more efficient resource management. By integrating spatial and non-spatial data from the Central Statistics Agency (BPS), this GIS visualizes the spatial distribution of coconut plantations and identifies production variations among sub-districts. The analysis reveals that Patebon Sub-district has the highest coconut production, while Cepiring Sub-district, despite having the largest land area, records relatively low production. Mapping was conducted using Quantum GIS (QGIS) software, allowing for accurate and efficient data digitization. This GIS output holds significant potential to support spatial planning, data-driven policy formulation, and the improvement of coconut farmers' welfare in Kendal Regency. The implementation of the map on a web-based platform facilitates public access to the presented spatial information.

Keywords: *Geographic Information System, Coconut, Kendal Regency*

1. Introduction

Young coconut fruit is one of the unique tropical plant products because, in addition to its flesh being directly consumable, its water can also be drunk without processing [1]. This fruit has high economic value as it can be utilized for various products, such as coconut milk, coconut oil, vinegar, as well as food and beverage ingredients. In the context of sustainable natural resource management, the utilization of young coconuts not only provides economic opportunities but also supports environmental conservation efforts.

Kendal Regency is divided into three regions: a hilly area in the central part, a mountainous area in the southernmost part, and lowlands and coastal areas in the north. Most of the land, accounting for 71.7%, is used for agriculture, which indicates that Kendal Regency is an agrarian region [2]. In the context of coconut cultivation, this agrarian potential can be optimized through the availability of accurate and up-to-date data. Based on data from the Kendal Regency Central Statistics Agency (BPS) in 2023, the area of coconut plantations and production yields provide important insights for formulating coconut resource management policies in the region.

Geographic Information Systems (GIS) is a highly relevant technology for supporting natural resource management, including in agrarian sectors such as coconut cultivation. GIS enables the collection, analysis, and visualization of spatial data accurately to better understand the distribution patterns and potential of resources. In the context of coconut cultivation in Kendal Regency, GIS can be used to map coconut plantation areas, analyze production yields, and identify environmental factors that influence productivity. A GIS-based approach allows for more measurable and data-driven decision-making, supporting effective, efficient, and sustainable planning efforts. The use of GIS in this research adds value by integrating statistical data with spatial maps, resulting in comprehensive information for the development of the coconut sector in Kendal Regency.

This research aims to map the extent of coconut plantations and analyze production yields in Kendal Regency in 2023 using data from the Central Statistics Agency (BPS). The results of this research are expected to provide comprehensive information on the current condition of coconut plantations in Kendal Regency, which can be utilized to support the more effective and efficient development of the coconut sector. The benefits of this research are anticipated to be felt by various parties, including local governments, business actors, and local communities, in sustainably managing coconut resources.

2. Research Methods

This study employs a methodology that involves the stages of data collection, data processing, data analysis, map digitization, and map implementation using QGIS software with OpenStreetMap features. The following are the steps undertaken in the research:

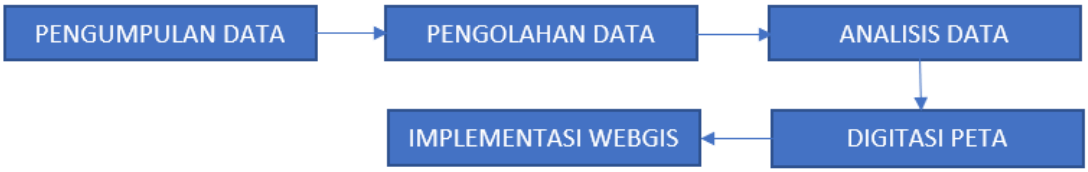

Fig. 1: Research methods

2.1. Data Collection

Spatial data collection was conducted through field surveys using high-accuracy GPS devices to determine the geographic coordinates of administrative boundaries, coconut plantation locations, and other geographic features. Non-spatial data, such as land area, the number of coconut trees, coconut varieties, and annual production yields, were obtained through document studies from the Central Bureau of Statistics of Semarang Regency and structured interviews with local farmers to ensure data validity.

2.2. Data Processing

Spatial data were processed using QGIS software through several stages, including converting coordinates into map layers, topology checks, and spatial analysis. Non-spatial data were organized in a CSV table format and integrated with spatial data through attributes such as location IDs or coordinates. Validation was carried out using cross-check methods across datasets to ensure consistency and accuracy before further analysis.

2.3. Data Analysis

Data analysis involved linking spatial and non-spatial information to evaluate the geographic distribution patterns of land area and coconut production yields. This analysis was performed using QGIS software to produce thematic maps and statistical reports supporting recommendations for coconut plantation management. The spatial and non-spatial data used in this analysis are presented in Figure 2 and Table 1:

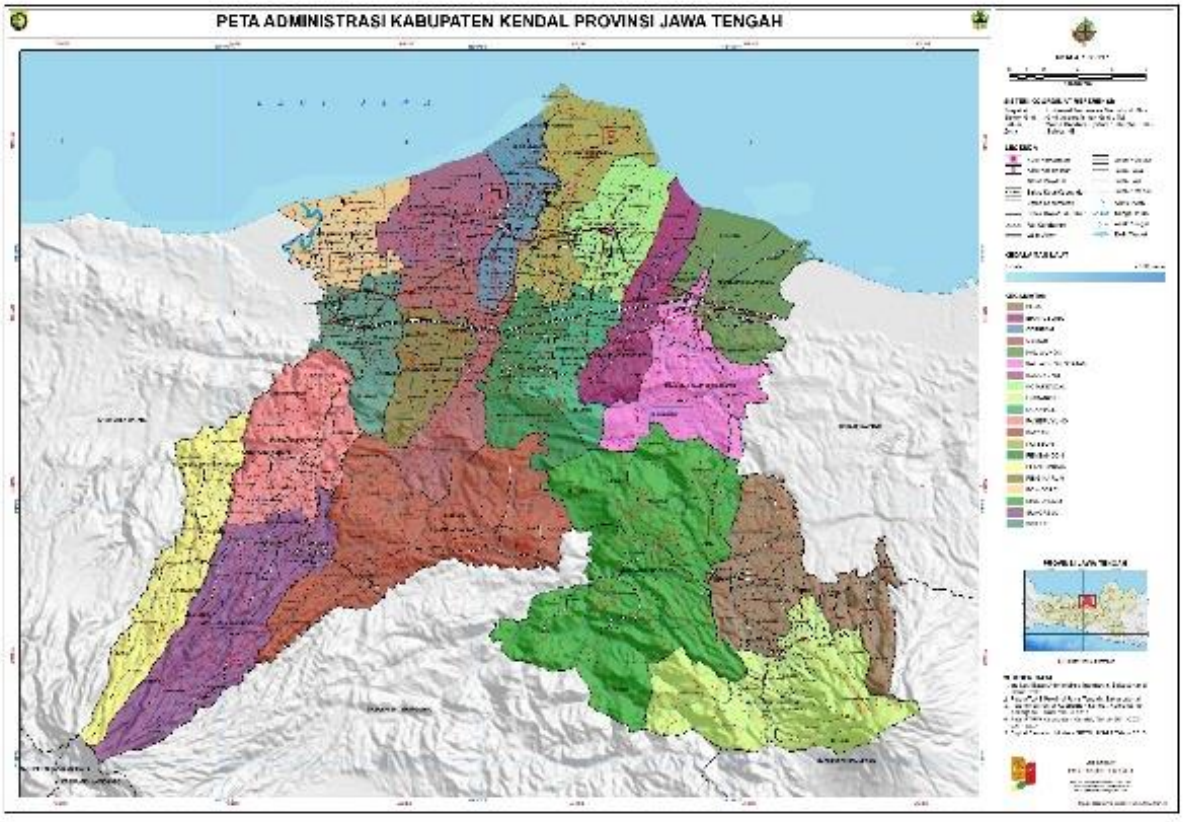

Fig. 2: Spasial data

Table 1: Coconut Yield and Production

Kecamatan	Luas(ha)	Hasil(ton)
Plantungan	38,9	17,45
Sukorejo	57,7	13,38
Pageruyung	135,8	64,89
Patean	112,58	14,65
Singorojo	70,6	61,4

Limbangan	79	94
Boja	88,15	32,01
Kaliwungu	3	4,5
Kaliwungu Selatan	9	13,5
Brangsong	21,4	11,1
Pegandon	10,6	3,65
Ngampel	2,53	1,67
Ringinarum	6,53	11,85
Weleri	0,46	1,37
Rowosari	37,45	1,02
Kangkung	22,2	4,15
Cepiring	167,96	51,5
Patebon	89,95	110,88
Kendal	4,15	2,21

2.4. Map Digitization

The digitization process was carried out using QGIS through two main methods: manual digitization for administrative boundaries and coconut land locations, and semi-automatic digitization using reference data from OpenStreetMap. The resulting map layers include administrative boundaries, coconut land locations, and road networks, stored in shapefile format. Layer validation was performed by comparing the digitization results with the latest satellite imagery to ensure accurate spatial representation.

2.5. WebGIS Implementation

After the thematic maps were created and analyzed, the implementation phase involved converting the map layers into GeoJSON and SHP formats using QGIS export features. The maps were then uploaded to OpenStreetMap as a WebGIS-based platform to facilitate public access. This publication aims to support spatial planning and regional development, particularly in optimizing coconut land use in Kendal Regency.

3. Results and Discussion

3.1. Map Digitization

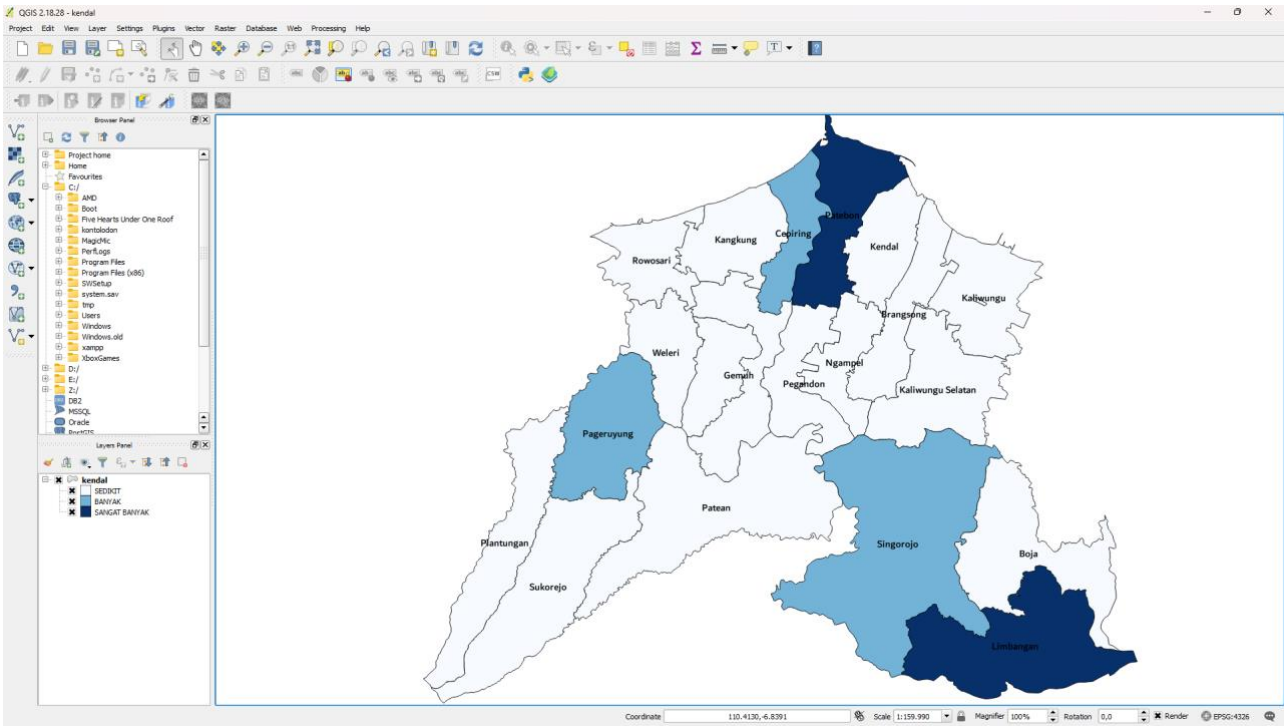

Fig. 3: Map Digitization Results

The map digitization process was conducted using Quantum GIS software through several stages, including coordinate conversion into map layers, topology checking, and spatial analysis.

3.2. Main Page

Fig. 4: Homepage

The homepage is designed to access and select available menus in the geographic information system (GIS) focused on mapping the area and coconut production in Kendal Regency. This page consists of various menus, including Home, About, Spatial Data, Non-Spatial Data, and Map. It also features a gallery menu showcasing products derived from coconuts based on the required data symptoms.

3.3. About Page

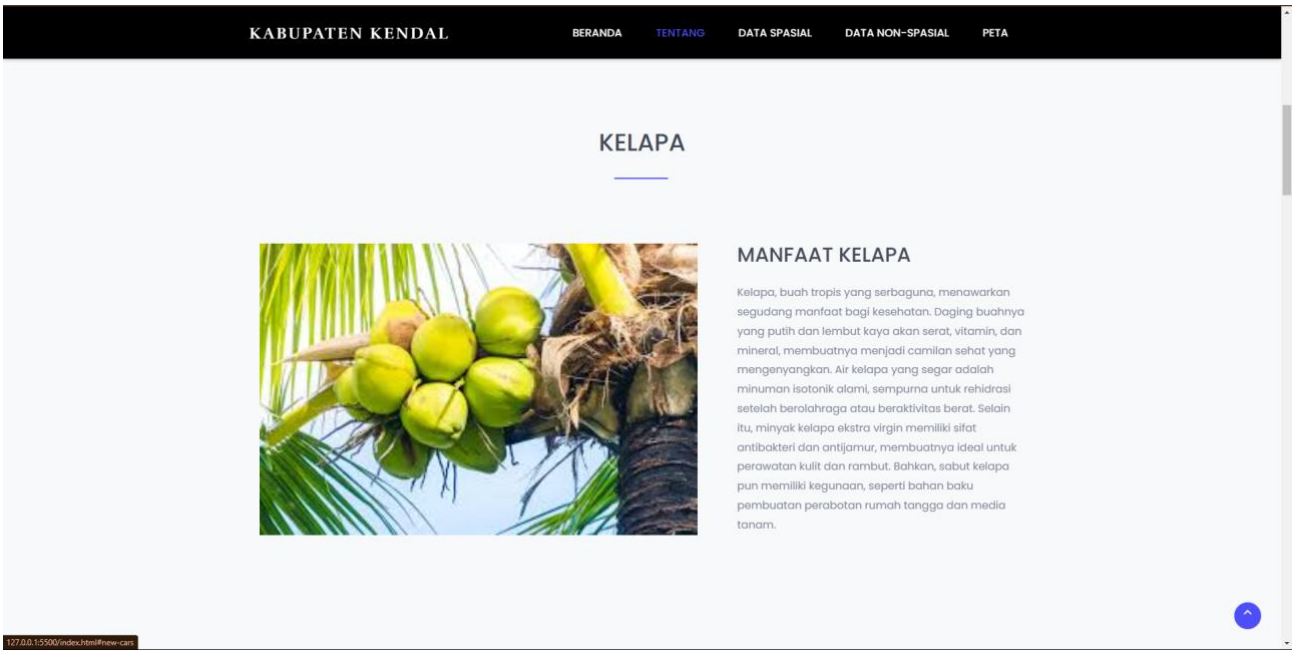

Fig. 5: About Page

The "About" page provides information about the benefits of coconuts, which can be processed into various products. Additionally, it highlights the health benefits of coconut-based products, such as extra virgin coconut oil, which is used for skin and hair care.

3.4. Thematic Map Page

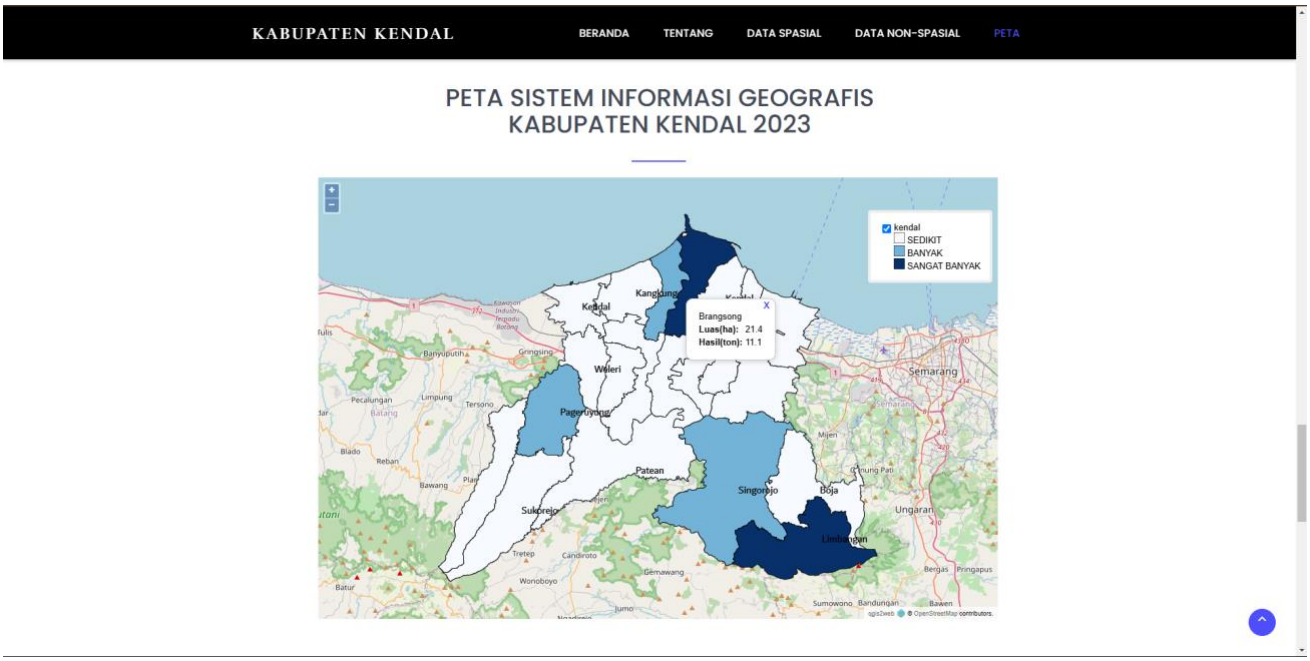

Fig. 6: Map of Coconut Area and Production Results

The thematic map page displays an interactive map showing the area and production results of coconuts with different colors depending on the size of the plantations in each district. It also includes detailed information on the size and production results of coconuts in each district.

3.5. Discussion

The digitized map presented illustrates the distribution of agricultural production in Kendal Regency based on plantation area and production output in each sub-district. The map's color gradient indicates production levels, with darker shades representing higher production and lighter shades indicating lower yields. This data provides a visual overview of agricultural productivity in each region, which can be utilized for in-depth analysis related to agricultural resource management and strategic planning for yield improvement.
According to the table data, Patebon Sub-district recorded the highest production at 110.88 tons with a plantation area of 89.95 hectares. This high production output demonstrates efficient land management in the sub-district, even though its plantation area is not the largest. A similar trend is observed in Limbangan Sub-district, which recorded a production output of 94 tons from 79 hectares, placing it among the regions with high productivity. Singorojo Sub-district also achieved significant production, amounting to 61.4 tons from 70.6 hectares, indicating great potential for further development.

Conversely, Cepiring Sub-district, which has the largest plantation area in Kendal Regency at 167.96 hectares, recorded relatively lower production at 51.5 tons. This could be attributed to various factors such as the type of crops cultivated, land management techniques, or less favorable soil conditions. Other areas, such as Rowosari and Weleri, reported very low production outputs of 1.02 tons and 1.37 tons, respectively, despite having notable plantation areas of 37.45 hectares and 0.46 hectares. This suggests the need for interventions to enhance efficiency and productivity in these regions.

Sub-districts with lower production outputs, such as Gemuh (1.67 tons), Pegandon (3.65 tons), and Kaliwungu (4.5 tons), also highlight challenges in plantation management. These challenges may stem from factors such as the lack of modern agricultural technology, limited access to agricultural resources, or less favorable environmental conditions. Meanwhile, sub-districts like Pageruyung (64.89 tons) and Boja (32.01 tons) show moderate production levels, which could be further improved with appropriate strategies.
This map serves as a valuable tool for understanding disparities in productivity across various sub-districts in Kendal Regency. Leveraging this data, the local government can devise more targeted strategies, such as providing agricultural technology assistance to regions with low production or expanding research on factors contributing to high productivity in areas like Patebon and Limbangan. Additionally, this data can be utilized to promote the adoption of sustainable farming practices aimed at enhancing productivity without compromising the local ecosystem.

4. Conclusion

Based on the conclusions of the analysis, the web-based geographic information system for coconut plantations in Kendal Regency in 2023 has been successfully implemented. This information system provides data regarding coconut plantations in Kendal Regency, such as mapping plantation areas and harvest production using an interactive map. The system holds great potential to support better decision-making efforts aimed at improving coconut production in Kendal Regency. It is expected that this information system will contribute to

development efforts to enhance coconut production in the region. The website testing results indicate that it functions well on browsers such as Google, Chrome, and Edge.

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