



The Optimal Location for The Development of Agricultural Production Center Area of Rembang Regency

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Abstract. Disproportionate regional spatial growth can encourage regional disparities between villages and cities and problems for the sustainability of regional development. Rembang Regency has growth characteristics that are concentrated at several points in its urban area. This pattern of growth creates a problem of regional disparity. To overcome this problem, it is necessary to add new regional growth centers. These new regional growth centers are expected to evenly distribute spatial growth. The center of regional growth in accordance with the characteristics of Rembang Regency is the center of agricultural production. This study aims to determine the optimal location for the development of the agricultural production centers as the center of regional growth. Using a spatial approach with remote sensing images as the main data. The analytical technique used is spectral transformation and multicriteria. The results showed that the most optimal locations for the development of agricultural production centers were Sale District (2,634.01 ha), Gunem District (2,198.95 ha) and Kragan District (2,171.72 ha). Sulang District is also a potential location for the development of agricultural production centers because the total area of the optimal location covers 8 – 10% of the total area of Rembang Regency. The findings of the study on the optimal location for the development of agricultural production centers are recommended as a strategic area for regional development to function as a growth center for Rembang Regency as an effort to overcome disproportionate spatial growth.

Keywords: optimal location, growth center area, agricultural production center, spectral transformation, multi-criteria

INTRODUCTION

Disproportionate spatial growth has always been the main focus of economists and regional developers [1], [2]. Disproportionate growth patterns are common in newly developed cities, and they can exacerbate regional disparities by encouraging economic inequality between regions [3]. The disproportionate growth pattern is caused by concentrated rapid development in a single urban area. As a result, the gap between rural and urban areas widens, resulting in regional inequities and other issues. [4]. Regional disparities are the main source of concern that must be addressed since they have a detrimental effect on social cohesion, policy unity, and the regional development sustainability [5], [6]. The creation of new growth centers is required to overcome the problem of disproportionate spatial growth by ensuring an even distribution of growth [7]. Agricultural production centers, also known as agropolitan development, are one of the new growth centers that can be developed in rural areas. The agropolitan area is one of the regional development strategies in increasing production and networking in rural and urban areas.[8] The

development of agricultural production centers or agropolitan can increase the productivity of rural areas which can affect economic growth. [9], [10]. This is expected to serve as a model for the dispersion of regional centers, allowing growth to occur outside of urban regions. The development of agricultural production center areas requires certain considerations related to determining their location. Determining the optimal location can determine the optimal output expected from regional development. The optimal location is the most strategic location. A profitable location is one that has an impact on the existence of various types of businesses/activities in order to increase regional income. Location theory is one of the theories that underlies the need for area-based development [11]. Rainfall, soil fertility, slope, and groundwater distribution are all criteria that can be used to determine the best site for the establishment of agricultural production center regions. A spectral transformation approach is utilized to map the organic content of carbon and water when using soil fertility parameter. [12]. NDVI and NDBI spectral transformations are used to map the condition of soil substance content [13], [14].

This study aims to determine the optimal location for the development of the agricultural production center in Rembang Regency, using the spectral transformation method and multi-criteria analysis. The growth characteristics of Rembang Regency are centered at a few points. The disproportionate growth of the urban areas of Rembang and Lasem, which developed twice as fast as the surrounding urban and rural areas, demonstrates this centralized growth. In addition, Rembang Regency has a population that is primarily employed in the primary agriculture industry. Rembang Regency, Central Java Province, is the study area, and it is located at the easternmost tip of Central Java. Rembang Regency has an area of 101,408 ha consisting of 14 sub-districts, 287 villages, and 7 urban villages. Rembang Regency consists of 12 urban areas where the northern part of the urban area is the center of economic growth and activity, especially the Rembang Urban Area and the Lasem Urban Area. [15].

METHODOLOGY

The research uses a quantitative descriptive method with a spatial approach. Remote sensing images are used as the main data. The analytical technique is spectral transformation and multi-criteria. [12]. The purpose of the study was to determine the optimal location for the development of the agricultural production center area as a growth center for the Rembang Regency. Using LANDSAT 8 OLI and ESRI satellite imagery Rembang Regency in 2019, as spatial data. The LANDSAT 8 OLI image is a multispectral satellite image consisting of 11 color bands [16].

Soil organic carbon content can be analyzed by spectral transformation Modified Normalized Difference Water Index (MNDWI). The formula for spectral transformation $(Green - SWIR)/(Green + SWIR)$ is then used to produce colors due to differences in organic matter content of the plant [17, 14, 18].

The Normalized Difference Vegetation Index or NDVI is the ratio of reflected radiation in the red and near infrared spectral areas that can detect the photosynthetic spectrum [19]. The NDVI spectral transformation can be used to map the water content in the soil or soil moisture [13] dan [14]. Research by Research by [20] has shown that the spectral transformation results have a strong correlation with soil moisture, so the same method is used to determine soil moisture in the study area

TABLE 1. Overlay Weighted Multicriteria Analysis

Variable	Indicator	Scor	Weight (%)
Soil fertility	<i>soil organic carbon</i>	1-5	15
	<i>soil moisture</i>	1-5	15
Topography	Percentage of slope	5-1	20
Hydrogeology	Aquifer productivity	1-5	40
Climatology	Rainfall	1-5	10

Source: Aymen et al., 2021 with modification

Table 1 shows the variables, indicators, scores, and the weight of each variable. Table 1 shows that each variable shows a directly proportional relationship except for the topographical variable. The optimal level is determined based on the total value of the weighted overlay analysis which is divided into five categories, namely Very Low, Low, Adequate, Medium and High.

The process of analysis was conducted as follows:

- Using the unsupervised classification approach to analyze land use, the goal is to determine the availability of land in Rembang Regency, which serves as an ideal location for the construction of agricultural production centers. According to Anderson, land classification relates to the classification of land cover. [21].
- Analysis of organic carbon in soil (SOC) aims to map organic carbon content in soil in Rembang Regency. MNDWI spectral transformation to bring out the soil organic carbon content while to bring out the color due to differences in soil organic matter content. performed inversion using the formula $(Green - SWIR)/(Green + SWIR)$.
- Analysis of water content in soil or soil moisture (SOM) is an analysis that aims to map soil moisture in the study area, using the NDVI spectral transformation with the formula $(NIR - Red)/(NIR + Red)$.
- Optimal location analysis for the development of agricultural production center areas is an analysis that aims to determine the most optimal location for the development of agricultural production center areas. Based on multi-criteria analysis technique with weighted overlay method. (Weighted overlay). Using the variable content of carbon organic matter and soil moisture as an indicator of the level of soil fertility as well as variables of physical aspects.

Figure 1 shows the analytical framework for determining the Optimal Location for the Development of the Agricultural Production Center Area of Rembang Regency

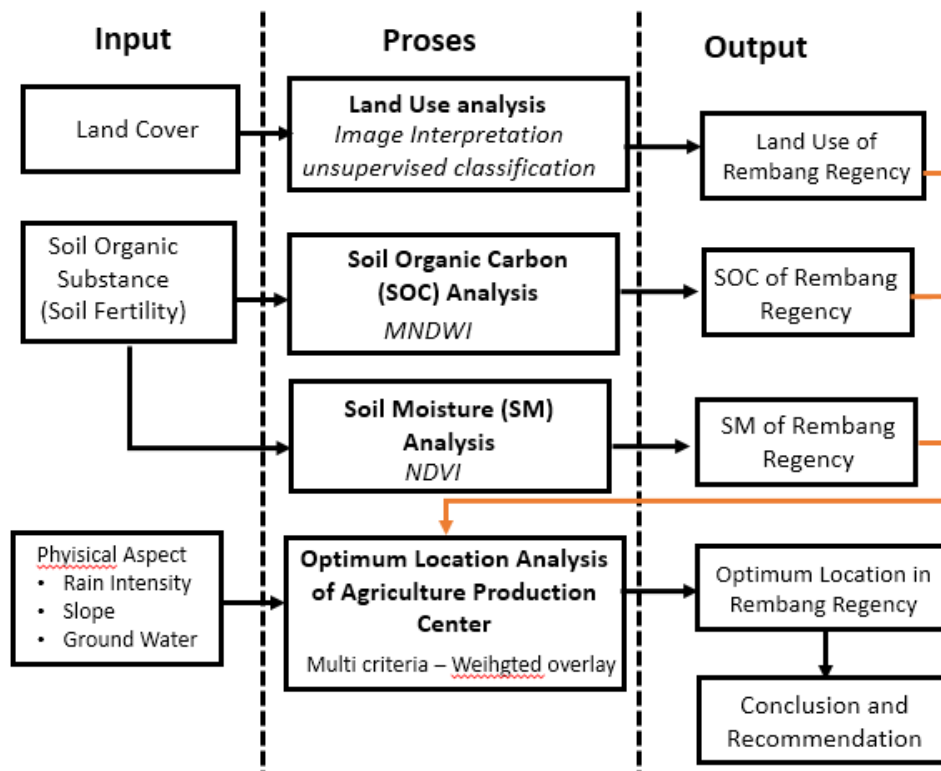


FIGURE 1. Analytical framework

RESULT AND DISCUSSION

Land use of Rembang Regency

Rembang Regency's land use is classified into four categories: residential, forests, agriculture, and unoccupied land. The area of non-built land in Rembang Regency is 88,906.03 ha (86.34 percent), while the area of agricultural land is 27.31 ha. Sulang District (3,061.67), Sarang District (3,039.73), and Pamotan District (3,061.67) all have large regions of agricultural land use (2,917.80). Table 2 depicts the land use area in Rembang Regency. The presence of huge expanses of undeveloped land allows for the extension of agricultural regions, hence increasing agricultural output. Rembang Regency could be developed as a growth center for the development of agricultural production centers, depending on the state of the land.

TABLE 2. Land Use of Rembang Regency

District	Land Use Area (ha)				Total
	Forest	Vacant land	Residential	Agriculture	
Kec. Bulu	5,708.64	2,236.44	659.24	1,638.33	10,242.66
Kec. Gunem	3,724.21	2,096.95	744.46	1,783.22	8,348.84
Kec. Kaliori	1,595.60	980.85	1,513.32	2,153.95	6,243.72
Kec. Kragan	2,329.28	1,518.88	1,041.90	1,920.52	6,810.58
Kec. Lasem	1,848.41	932.47	631.08	1,025.42	4,437.38
Kec. Pamotan	1,933.36	2,256.57	1,334.39	2,917.80	8,442.11
Kec. Pancur	1,961.45	962.17	537.40	996.63	4,457.66
Kec. Rembang	1,308.39	892.19	1,439.32	2,205.39	5,845.29
Kec. Sale	5,946.40	2,683.06	532.80	1,614.77	10,777.02
Kec. Sarang	2,726.02	2,616.01	734.41	3,039.73	9,116.17
Kec. Sedan	2,908.94	2,103.47	1,147.54	2,227.92	8,387.86
Kec. Sluke	1,543.39	751.09	524.99	1,031.06	3,850.53
Kec. Sulang	1,454.91	1,969.13	1,761.55	3,061.67	8,247.25
Kec. Sumber	1,844.85	1,945.45	1,467.38	2,511.05	7,768.72
Total (ha)	36,833.86	23,944.72	14,069.78	28,127.45	102,975.81
Total (%)	35.77	23.25	13.66	27.31	100.00

Based on the distribution of land use in Rembang Regency, it is clear that the population of Rembang Regency is concentrated in two points in the urban area, namely Rembang District and Lasem District. Rembang Regency has a concentrated and uneven growth pattern. The disproportionate growth pattern widens the development gap between rural and urban areas, resulting in regional inequities and challenges with regional development sustainability. Figure 2 depicts the land use distribution in Rembang Regency.

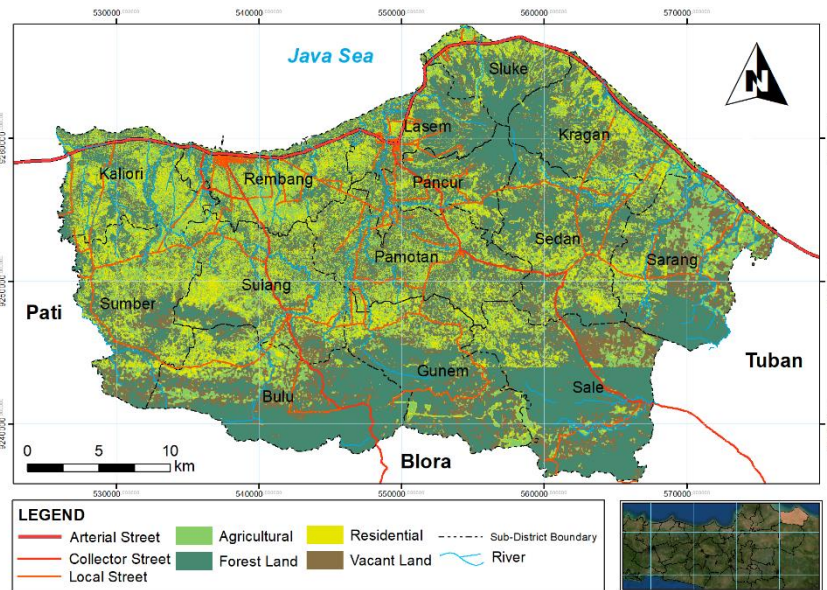


FIGURE 2. Landuse Map of Rembang Regency

Soil Organic Carbon in Rembang Regency

Organic carbon content in the soil is a key indication for determining soil fertility. Soil organic carbon analysis in Rembang The five classifications of soil organic carbon analysis in Rembang Regency are Very Low, Low, Adequate, Medium and High. Distribution of soil organic carbon category is quite evenly distributed in Rembang Regency. Meanwhile, Sulang District (1,545.11 ha), Sumber District (1,257.13ha) and Pamotan District. (1,167.62 ha) and Rembang District (1,130.47 ha) had the highest levels of soil organic carbon (1,130.47 ha). Figure 3 shows the distribution of soil organic carbon in Rembang Regency.

Sulang District (19%), Rembang District (19%), Sumber District (16%), and Pamotan District (14%) have a high category of soil organic carbon based on the percentage of sub-district area. The optimal location for the development of agricultural production centers is an area that contains a high category of soil organic carbon. The higher the organic carbon content of the soil, the more optimal the location is to be developed as a center for agricultural production. The content and concentration of soil organic carbon are crucial factors in maintaining the sustainability of soil functions. [22], [23].

Locations with a high category of soil organic carbon content are the most optimal locations for the development of the agricultural production center area of Rembang Regency. The higher the organic carbon content of the soil, the more optimal the location is to be developed as a center for agricultural production. The results of the analysis show that the Rembang District, Sulang District, Sumber District and Pamotan District meet the criteria as the optimal location for the development of agricultural production centers based on soil organic carbon. Figure 3 shows distribution of Soil Organic Carbon in Rembang Regency.

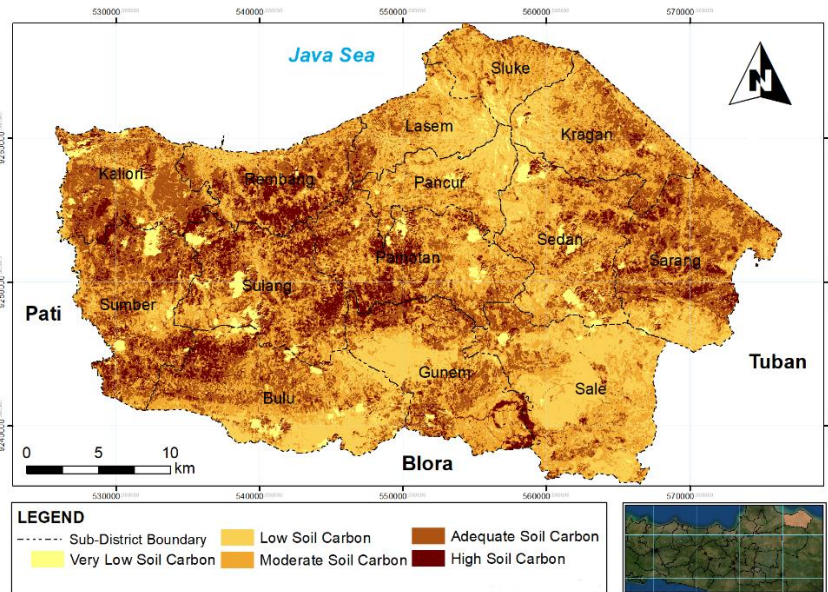


FIGURE 3. Soil Organic Carbon Map of Rembang Regency.

Soil Moisture in Rembang Regency

The water content of the soil, also known as soil moisture, serves a variety of purposes, including fertility and the development of agricultural land. Soil moisture, or water content in the soil, has many functions, especially for fertility and agricultural land development [24], [25]. Soil moisture in Rembang Regency is classified into 5 categories: Very Low, Low, Adequate, Medium and High. The soil moisture categories is evenly distributed in the Rembang Regency area. Soil moisture in the high category was mostly found in Kragan District (1,988.16 ha) and Sedan District (1,869.23 ha). Figure 4 shows the distribution of soil moisture in Rembang Regency.

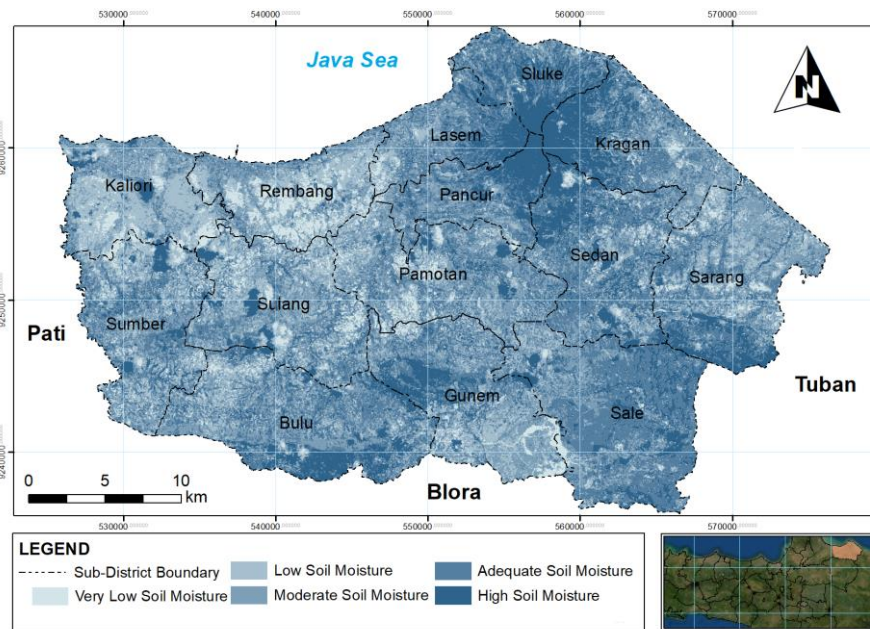


FIGURE 4. Soil Moisture Map of Rembang Regency

Based on the percentage of sub-district area, high soil moisture category is detected in Sluke District (37%), Kragan District (29%) and Sedan District (22%). An area with a high percentage of high soil moisture content is the optimal location for the development of agricultural production centers based on soil moisture. The higher the moisture content of the soil, the more optimal the location is to be developed as a center for agricultural production. The results of the analysis show that Sluke, Kragan and Sedan sub-districts have met the criteria as the optimal location for the development of agricultural production centers based on soil moisture.

Optimal Locations for Development of Agricultural Production Center of Rembang Regency

Using spatial data and multi-criteria analysis techniques, the optimal location for the development of Rembang Regency's agricultural production center region was determined. The results of the previous study were used as input, followed by a geographical analysis using climatological (rainfall), hydrogeological (groundwater), and topographical (slope) variables. Data sources for rainfall, groundwater and slopes were obtained from maps [26], [27]. The following is a picture of the spatial distribution of each variable; Figure 5 shows the distribution of rainfall in Rembang Regency, Figure 6 shows the distribution of groundwater productivity in Rembang Regency and Figure 7 shows the distribution of slopes in Rembang Regency.

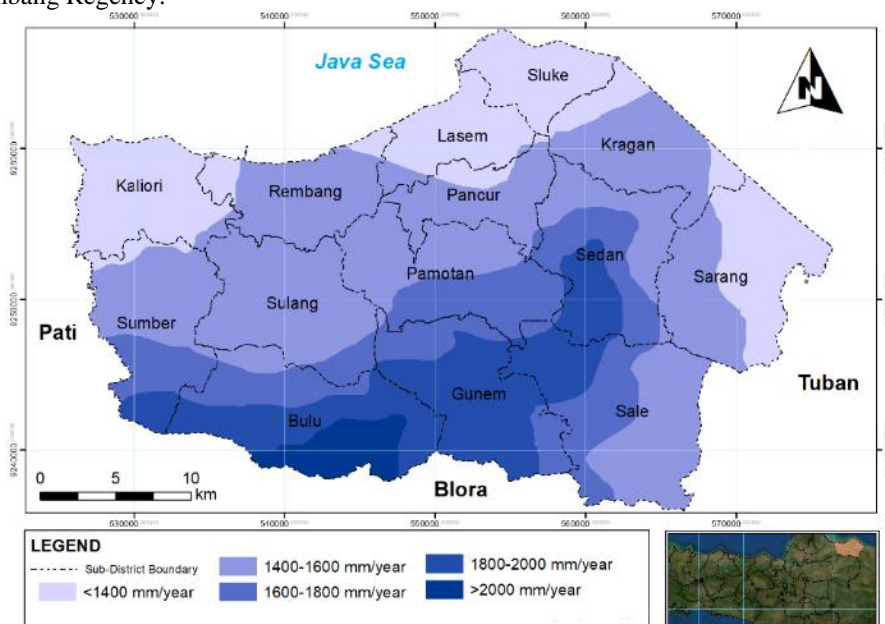


FIGURE 5. Distribution of rainfall in Rembang Regency

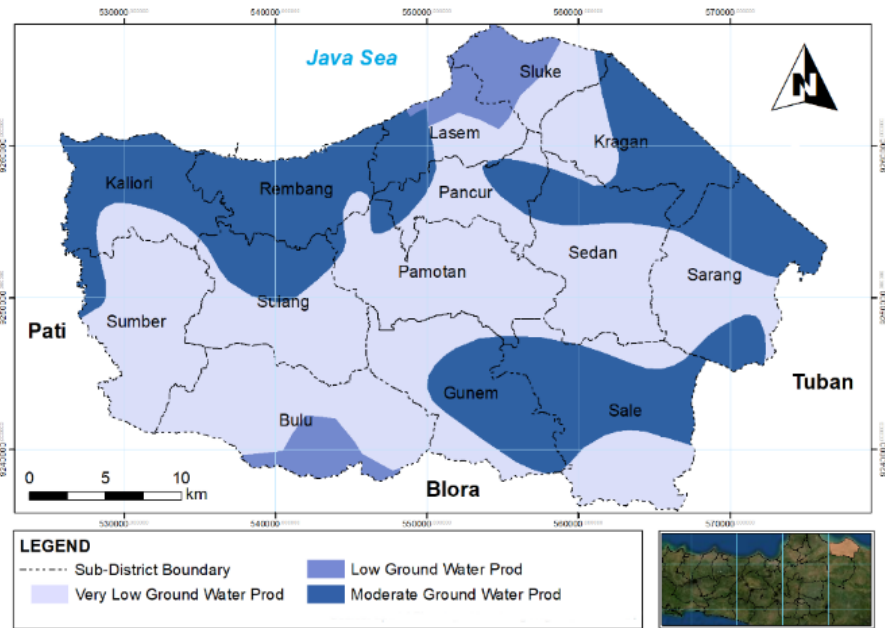


FIGURE 6. Distribution of groundwater productivity in Rembang Regency

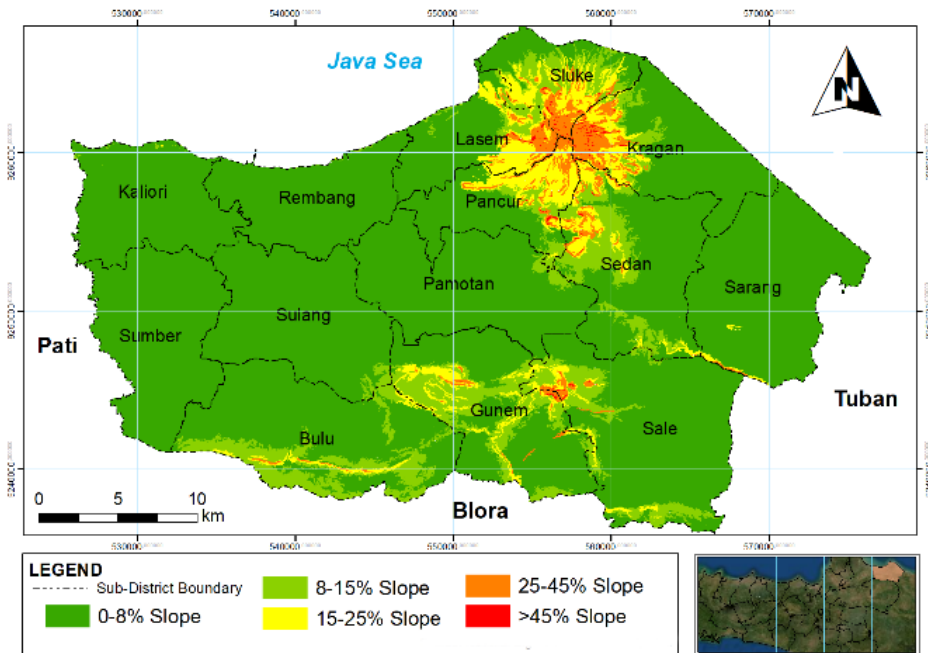


FIGURE 7. Distribution of slopes in Rembang Regency

The most optimal location for the development of agricultural production center areas is a location with moderate to high rainfall criteria, high soil fertility, high groundwater productivity, and flat slopes. [12]. Rembang Regency has met these criteria except for groundwater productivity. Analysis of the optimal location for the development of agricultural production centers in Rembang Regency is classified into 5 categories: Very Low, Low, Adequate, Medium, and High. The high optimal level category does not show in the results of this analysis because the intensity of aquifer production has a substantial effect on the optimal level of a place with a high score/weight, whereas groundwater productivity in Rembang Regency is only in the very low to medium category. This is in accordance

with the results of the study Aymen et al (2021) which shows the intensity of aquifer production has a large effect on the optimal level of location for the development of agricultural areas.

Overall, the results of the study showed that the Optimal Locations for the Development of Agricultural Production Centers in Rembang Regency were dominated by locations with an adequately optimal level, while the Optimal Locations for the Development of Agricultural Production Centers in Rembang Regency with medium categories were in Kragan District, Sedan District, Sarang District, Sulang District, Gunem District, Bulu District, Sumber District and Sale District with an area of 10.47% of the total area of Rembang Regency (2,634.01 ha). Figure 8 shows the optimal location for the development of the Agricultural Production Center Area of Rembang Regency in various levels.

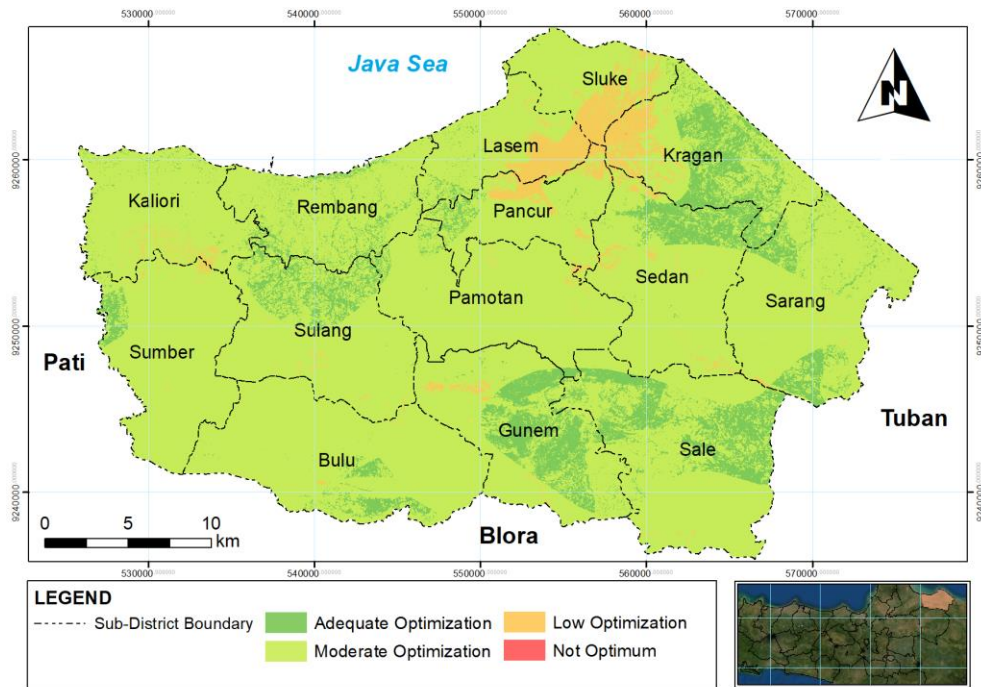


FIGURE 8. Map of Optimal Locations for Agricultural Production Center Areas of Rembang Regency

CONCLUSION

The results showed that the most optimal locations for the development of agricultural production centers were Sale District (2,634.01 ha), Gunem District (2,198.95 ha) and Kragan District (2,171.72 ha). The intensity of groundwater production has a significant effect on the optimal level for determining where agricultural production areas should be developed. No optimal location was found in the high category because the score for groundwater production criteria was the highest while groundwater productivity in Rembang Regency was only in the very low to moderate category. Sulang District is also a potential location for the development of agricultural production centers because the total optimal location covers 8–10% of the total area of Rembang Regency. This is in accordance with the Rembang Regency Spatial Plan for 2011–2031 which aims to make Sulang District a center for agricultural production. Research findings about the optimal location for the development of agricultural production centers can be recommended as a strategic area for development that focuses on agriculture. This is one of the efforts to equalize the growth center of Rembang Regency to overcome disproportionate spatial growth.

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