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Analysis of Spatial-Based Correction of Raw Rice Field Land on Potential Land Recommendations in Serdang Bedagai Regency

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ABSTRACT

Effective regional planning is very important in maintaining food security, especially in areas with significant agricultural potential such as Serdang Bedagai Regency, North Sumatra. This study aims to conduct a spatial-based rice field correction analysis to validate and update rice field data that has been determined through the Decree of the Ministry of Agrarian and Spatial Planning/National Land Agency (ATR/BPN) No. 686 of 2019. Using Geographic Information System (GIS) technology, this study integrates rice field map data, the latest satellite imagery, and field data to evaluate the actual condition of rice fields in Serdang Bedagai Regency. The results of the analysis showed that there was a decrease in the area of rice fields by 704.90 ha compared to the data of the Decree of the Ministry of ATR/BPN, with around 4,645.40 ha of rice fields that have not been mapped. The data obtained also identified potential rice fields based on the availability of irrigation and land conditions, with a total potential land of 41,233.27 ha. Overlay analysis revealed significant differences between raw paddy field data and actual conditions in the field, indicating land conversion that requires special attention. This study provides strategic recommendations for better management of paddy fields and the need to adjust raw paddy land data to support food security. These findings are not only relevant for local policies but can also be used as a model for other regions in Indonesia in their efforts to maintain and manage agricultural land sustainably.

Keywords:

Food Security, Rice Fields, Spatial Correction, Geographic Information System (GIS), Serdang Bedagai Regency

I. INTRODUCTION

So that regional planning planning must be accompanied by regional elements. Regional planning is to know and analyze current conditions, forecast the development of various related factors that are not controlled, estimate limiting factors, set goals and objectives that are expected to be achieved, set measures to achieve these goals, and determine the location of development. (Feby, 2023).

Food security is a situation in which all people have adequate access to sufficient, nutritious, and safe food to support a healthy life. In Indonesia, food security has a crucial role in maintaining economic stability and community welfare, so it is one of the government's top priorities. The availability of agricultural land, especially rice paddy fields, which is the main source of rice production, is vital in supporting food security. Rice, as a staple food for the majority of the population, makes rice fields an essential element in the national food production chain.

This is useful for realizing sustainable exploitation for the good of contemporaries and looking at generations. On the authority of Billing No. 26 of 2007, to understand the efforts to improve continuously, spatial planning is needed. The provision of space is related to each get-up-and-go point of view so that the agreement wants to have an expansion of the provision process. The provision of space is a transaction of the process of providing space, the use of counseling, and controlling the use of counseling. supporting diplomatic negotiations on Agricultural Regulations and Spatial Planning, first in 2018, Spatial Planning. (Yahya Naufal Hawari, Abdiyanto, Abdi Sugiarto, 2024).

However, rice fields in Indonesia face great pressure from various sectors, especially due to the conversion of land into residential, industrial, and infrastructure areas. Rapid urbanization, coupled with development policies that do not always pay attention to the sustainability of agricultural land, often results in a significant reduction in productive paddy fields. This condition poses a serious threat to national food security if not handled appropriately and immediately.

As an effort to maintain the sustainability of rice fields, the government through the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency (ATR/BPN) has issued Decree No. 686 of 2019, which stipulates the standard land for rice fields throughout Indonesia. This decree is designed to protect rice fields that have been determined, so that they are not converted to other uses, so that the sustainability of national food production is maintained.

However, the implementation of this decree faces challenges in ensuring the accuracy of data on the rice fields listed. Some of the rice fields that have been registered may be unproductive or have undergone changes in function before the determination is made, so spatial-based corrections are needed to validate and update the data of the rice fields.

Serdang Bedagai Regency in North Sumatra is an area that has great agricultural potential, especially in rice production. However, like many other areas, Serdang Bedagai also faces threats from land use conversion and land use changes that can negatively impact the sustainability of its agricultural sector. Therefore, it is important to conduct a spatial-based rice field correction analysis in this region, to ensure that the existing raw rice field data is really accurate and reflects the conditions in the field.

The use of Geographic Information System (GIS) technology in the process of correcting rice fields is very important because it allows for the processing of spatial data with high accuracy. GIS can provide a clearer picture of the actual condition of the paddy field, so that it can support better decision-making. Through proper analysis, recommendations for potential land suitable for agriculture in Serdang Bedagai Regency can be produced, which will ultimately strengthen food security efforts in the area.

The conversion of agricultural land has a wide impact in various fields, therefore control efforts are needed that can control the rate of conversion of agricultural land to non-agricultural use. Law No. 41 of 2009 concerning the Protection of Sustainable Food Agricultural Land (Law No. 41/2009) which is the main basis in efforts to secure rice fields for food production, needs to be further elaborated by the Regional Government as determined that the Regency/City Government prepares a proposal for the planning of Sustainable Food Agricultural Land (LP2B). (Andriawan, Martanto, Muryono. 2020)

This research is not only significant for local policies, but can also be used as a model for other regions in Indonesia in managing agricultural land more efficiently and sustainably. Spatially-based rice field data correction and validation is an important tool in sustainable development planning, especially in relation to national food security.

II. LITERATURE REVIEW

A. Law No. 26 of 2007

Law Number 26 of 2007 concerning Spatial Planning is the legal basis for spatial planning in Indonesia. This law aims to create a safe, comfortable, productive, and sustainable regional space based on the Nusantara Insight and National Resilience. The following are the key points of Law No. 26 of 2007 that are relevant to the protection of sustainable food agricultural land:

1. Spatial Planning Objectives
2. Basic Spatial Planning Policy
3. Regional Spatial Plan
4. Sustainable Food Agricultural Land Protection
5. The Role of the Government and the Community
6. Sanctions and Legal Punishment

B. Land Use and Food Security

Food security in Indonesia is highly dependent on the availability of productive agricultural land, especially rice fields. According to Sitorus (2016), rice fields have an important role in ensuring stable food production, especially rice as a staple food. However, agricultural land, especially paddy fields, often undergoes changes in use caused by the pressures of infrastructure development, urbanization, and the conversion of land for other non-agricultural purposes. These changes can reduce the ability of land to support food security, and if not managed properly, can lead to future food crises. In line with that, research conducted by the Central Statistics Agency (2020) shows that the number of productive rice fields in Indonesia has decreased in recent years due to land conversion. Suboptimal land management can lead to a decrease in agricultural production capacity, which has a negative impact on national food security.

C. Geographic Information System (GIS) in Land Management

Geographic Information Systems (GIS) are an important tool in land management, especially in spatial mapping and analysis. According to Setiawan (2017), GIS allows for comprehensive visualization, manipulation, and analysis of geographic data, which is very important in land use monitoring and planning. GIS also allows the integration of spatial data with non-spatial data, so that it can provide a more accurate picture of land conditions, including rice fields. In the context of this study, GIS is used to correct rice fields by validating land data that has been determined through the Decree of the Ministry of ATR/BPN No. 686 of 2019. With GIS technology, spatial data of rice fields can be processed and analyzed in detail, so that land that is still productive and land that has changed functions can be identified. Research by Sulistyo (2018) shows that GIS can improve accuracy in agricultural land management and provide more appropriate recommendations for decision-making related to land use.

D. Government Policy in Determining Raw Rice Field Land

The government's policy in determining raw rice fields aims to protect rice fields from uncontrolled conversion of functions. Decree of the Ministry of ATR/BPN No. 686 of 2019 is one of the strategic policies taken by the government to ensure that rice fields in Indonesia continue to be used for agricultural purposes. This policy aims to maintain national food security by ensuring that rice fields that have been designated should not be converted for other purposes without clear permission. However, according to research by Wibowo and Sukardi (2019), there are challenges in the implementation of this policy, especially related to the accuracy of the rice field data used. Many rice fields recorded in the decree have changed their function or are no longer productive, so efforts are needed to correct and validate spatially-based rice field data to ensure that this policy can be implemented effectively.

E. Spatially-Based Rice Field Correction

Spatial-based rice field correction is the process of validating and adjusting rice field data with actual conditions in the field using GIS technology. This process is important to ensure that the land data used in planning and decision-making truly reflects the situation on the ground. A study by Prasetyo (2020) shows that spatial correction can help identify paddy fields that are no longer

productive or have switched functions, so that the data used for the determination of paddy fields is more accurate and relevant. In this study, spatial-based rice field correction will be applied in Serdang Bedagai Regency to update and validate existing rice field data, as well as provide recommendations on potential land that can be further developed to support food security in the area.

III. METHOD

A. Research Area

This research was conducted in Serdang Bedagai Regency, North Sumatra Province, which is one of the areas with high agricultural potential, especially in rice production. Serdang Bedagai Regency is located in the eastern part of North Sumatra and is directly adjacent to the Malacca Strait to the east, which influences the climatic conditions and soil fertility in this region. Administratively, Serdang Bedagai Regency consists of 17 sub-districts and 243 villages/sub-districts, with an area of about 1,900 km².

The topography of this region is dominated by lowlands, which makes it very suitable for agricultural activities, especially rice paddy cultivation. The district also has a fairly good irrigation system, which supports the intensification of agriculture in a number of areas. However, like other regions in Indonesia, Serdang Bedagai Regency faces challenges in maintaining rice fields due to pressure from non-agricultural activities such as housing, industry, and infrastructure development.

The rate of conversion of agricultural land to non-agricultural land in this area is quite significant, which threatens the sustainability of food production in the future. The selection of Serdang Bedagai Regency as the location of the research was based on several considerations. First, this district is one of the rice production centers in North Sumatra, so it has an important role in supporting food security at the provincial and national levels. Second, this region is also experiencing quite complex land use dynamics, with pressure from various sectors that have the potential to reduce the area of productive agricultural land.

This study will focus on the analysis of rice field correction in several sub-districts that have significant rice fields, such as Perbaungan District, Sei Rampah District, and Dolok Masihul District. These three sub-districts were chosen because they are the main rice-producing areas in Serdang Bedagai Regency, but they also face major challenges from land conversion.

Through GIS-based spatial analysis, this study will map the actual condition of rice fields in the study area, as well as identify land that is still productive and that has undergone a change in function. The results of this study are expected to provide useful recommendations for local governments and other stakeholders in an effort to maintain and manage rice fields in Serdang Bedagai Regency more effectively.

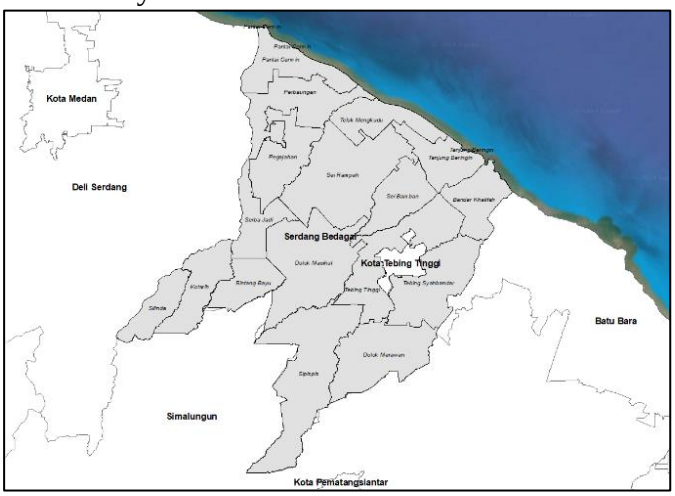


Figure 1. Research Study Area

B. Research Approach

This study uses a quantitative approach by utilizing Geographic Information System (GIS) technology for spatial analysis. This approach was chosen because it allows for a comprehensive analysis of the spatial data of rice fields in Serdang Bedagai Regency. The data used includes rice field maps from the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency (ATR/BPN), the latest satellite imagery, and field data collected through direct surveys. Spatial analysis was carried out to map the actual condition of rice fields, identify changes in land use, and make corrections to the raw rice field data that has been determined by the Decree of the Ministry of ATR/BPN No. 686 of 2019.

This approach allows researchers to get an accurate picture of the distribution and condition of paddy fields in the study area, as well as provide recommendations for more effective land management in supporting food security. In addition, this approach also involves descriptive analysis of secondary data, such as agricultural statistics and land-use policy reports, to understand the dynamics of paddy land use in Serdang Bedagai Regency and its implications for food security.

C. Data Collection Techniques

This study uses several data collection techniques to obtain accurate and relevant information related to the condition of rice fields in Serdang Bedagai Regency. The data collection techniques used are as follows:

a. Secondary Data Collection

Secondary data was obtained from various official sources, such as rice field maps from the Ministry of Agrarian and Spatial Planning/National Land Agency (ATR/BPN), the latest satellite imagery, as well as reports and statistics from the Central Statistics Agency (BPS) related to land use and agricultural production in Serdang Bedagai Regency. This data is used for initial analysis and mapping of rice fields as well as a basis for validation and correction of spatial data.

b. Primary Data Collection

Primary data was collected through a field survey conducted by involving agricultural extension workers as the spearhead in data collection and presenting information on agricultural attributes as a reference in mapping potential land in all sub-districts in Serdang Bedagai Regency. The survey involves direct observation of paddy field conditions, interviews with farmers and related parties, and the use of the avenza maps application device as a substitute for GPS to map specific points that require verification. The data obtained from these field surveys are used to validate secondary data and ensure the accuracy of spatial analysis.

D. Data Analysis

The analysis method in this study is designed to evaluate and correct rice field data in Serdang Bedagai Regency by utilizing Geographic Information System (GIS) technology. The steps and analysis techniques applied are as follows:

a. Spatial Data Processing

Spatial data obtained from satellite imagery and maps of early rice fields were processed using GIS software. The first step involves processing satellite imagery to obtain the latest information regarding land use. This data is then combined with existing rice field maps to produce layers that show the current condition of rice fields. This processing includes the process of georeferencing, digitization, and mapping of rice field features.

b. Overlay Analysis

Using the overlay technique, the rice field data from the map of the Decree of the Ministry of ATR/BPN No. 686 of 2019 was compared with the latest data from satellite images. This process aims to identify differences and changes that occur, such as land conversion and decreased

productivity. This analysis technique allows for the visualization of land use shifts as well as the identification of areas that require special attention for correction.

c. Data Correction and Field Validation

The data that has been analyzed through overlays will be re-examined with primary data obtained from field surveys. Validation is carried out to ensure that the existing data is in accordance with the actual conditions in the field. If a discrepancy is found between secondary data and field data, improvements will be made to update the paddy field information. This process involves field checks, verification of location points, and interviews with farmers to obtain more information regarding the status of the land.

Preparation of Recommendations

Based on the results of the analysis, recommendations will be prepared for better management of rice fields in Serdang Bedagai Regency. These recommendations include strategies to protect productive paddy fields, optimize the use of existing land, and measures that can be taken to prevent inappropriate land conversion. This recommendation aims to support food security policies and sustainable management of agricultural resources. This analysis method aims to provide a comprehensive overview of the condition of rice fields, identify existing problems, and suggest effective solutions to maintain agricultural sustainability in Serdang Bedagai Regency.

IV. RESULTS AND DISCUSSION

A. Spatial Analysis

The spatial data management analysis in this study aims to accurately map and evaluate the condition of rice fields in Serdang Bedagai Regency. Spatial data management involves several key stages carried out with the help of Geographic Information System (GIS) technology, and consists of the following steps: Spatial Data Collection and Integration The first step in spatial data management analysis is the collection of data from various sources.

The spatial data used includes rice field maps from the Ministry of Agrarian and Spatial Planning/National Land Agency (ATR/BPN), the latest satellite imagery, and field data obtained through surveys. This data is integrated in the GIS platform to ensure that all relevant information is available in one coordinated system. Georeferencing and Digitization Process Satellite imagery data and early paddy field maps require a georeferencing process to ensure that the data corresponds to the correct geographical coordinates. This process involves adjusting the images and maps so that the data obtained can be accurately compared with other reference data. After georeference, digitization is carried out to convert the map data into a vector format that can be further analyzed in GIS.

Tabel. 1 Table of Results of Analysis of Spatial Data Processing on Raw Rice Field Land in 2019 in Serdang Bedagai Regency

Land Use	Rice Field Area in 2019
Road Bodies	117.25
Pool	2.00
Plantation	52.08
Settlements	126.57
Paddy	27,435.52
Palm	139.25
Bush	55.88
Silver	0.22
Tegalan	53.92

Water Body	157.74
Total Area	**28,140.42**

Source : Processing Results, 2024

The table above shows the results of the spatial analysis carried out which resulted in changes in rice fields in Serdang Bedagai Regency based on the basemap of the spatial map of Raw Rice Fields (LBS) Decree of the Minister of ATR/BPN No. 686 of 2019. According to the basemap of Raw Rice Field Land (LBS) Decree of the Minister of ATR/BPN No. 686 of 2019, Serdang Bedagai Regency has an area of 28,140.42 Ha and if corrected based on the appearance of google satellite images, it has decreased to 704.90 Ha. There are around 4,645.40 hectares of rice fields in Serdang Bedagai district that have not been mapped based on the Basmape Decree 686 of 2019. In total, for Serdang Bedagai Regency, the damage to rice fields reached 32,080.92 Ha. For more details, you can see the map image of the results of spatial digits analysis in Serdang Bedagai Regency below.

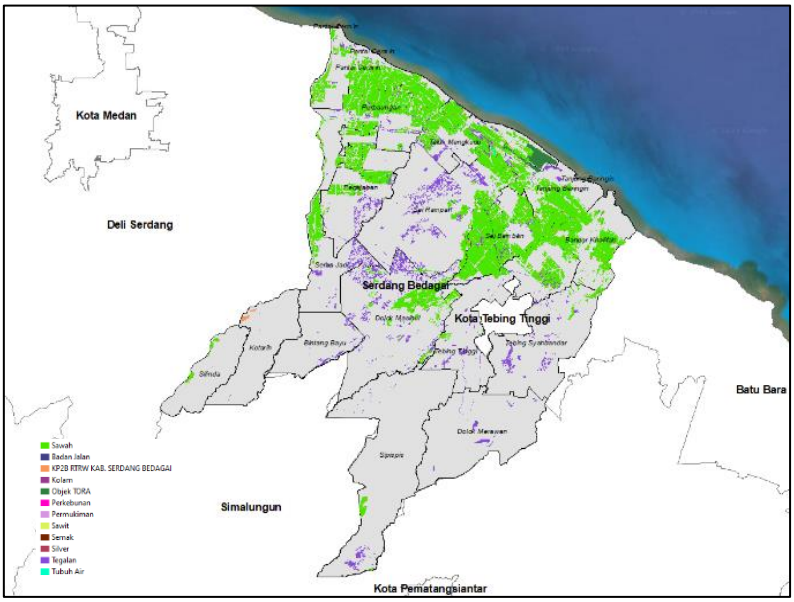


Figure 2. Results of Spatial Analysis

B. Potential Land Analysis Based on Field Data Comparison

Potential land analysis based on field data comparison is an important step in this study to determine and recommend land that has the best potential for agriculture, especially for rice production in Serdang Bedagai Regency.

The field data collected was compared with the spatial data obtained from satellite images and maps of rice fields. This comparison process is carried out using overlay analysis techniques in GIS to identify the conformity between the actual conditions in the field and the data recorded on the map. Differences between field data and existing spatial data can reveal information about changes in land use, decreased productivity, or areas that have not been properly recorded.

After evaluation, land that meets the criteria of quality and suitability for agriculture is identified as potential land. These lands are sorted by their level of potential production, taking into account the results of field surveys and spatial data. The identification of potential land aims to recommend areas

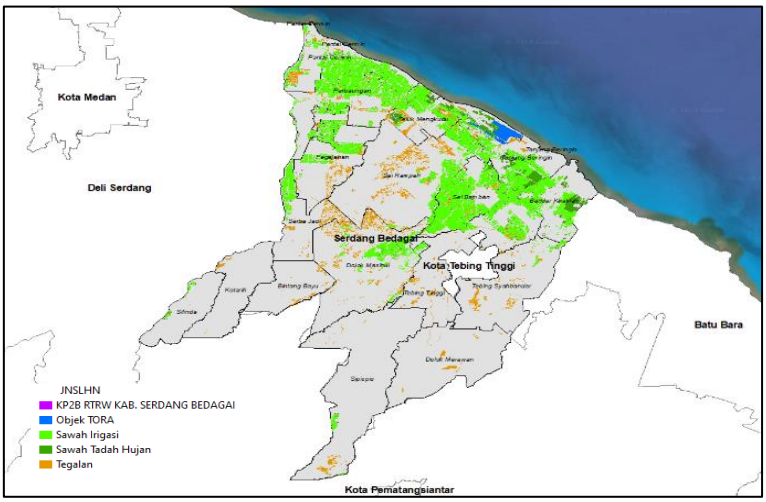
that can be further developed to improve food security and support the sustainability of agricultural production. For more details, you can see the description of the table below.

Tabel. 2 Types of Potential Land in Serdang Bedagai Regency

Identification Results	**Availability of Irrigation Conditions**			**Total Area**
	No Irrigation Available	Good	Bad	
RTRW Food Crop Area	890.14			890.14
TORA Land	803.45			803.45
Irrigation Rice Fields	5,237.00	23,164.33	999.89	29,401.22
Rainfed Rice Fields	2,105.78			2,105.78
Tegalan	7,332.80	13.87		7,346.67
Grand Total	**17,055.18**	**23,178.19**	**999.89**	**41,233.27**

Source : Processing Results, 2024

The table above shows the potential land based on the type of land in Serdang Bedagai Regency according to the availability of irrigation and the condition of the rice field expanse. According to the table above, Serdang Bedagai Regency has rice fields which are irrigated land with good conditions with an area of 23,164.33 Ha, types of rice fields with poor irrigation conditions reaching 999.89 Ha and there are expanses of rice fields that have not been irrigated reaching 5,237 Ha. From the results above, it is also illustrated that there is rice field whose type is rainfed rice field with a rice field area of 2,105.78 Ha. In addition to the mapped rice fields, this study also identified other land that is potential land to maintain food security such as land: Tegalan, food crop areas based on the spatial plan of Serdang Bedagai Regency, and land for agrarian revorma objects sourced from the National Land Agency in Serdang Bedagai Regency. For more details, you can see the map of the distribution of potential land in Serdang Bedagai Regency below.



C. Overlay analysis

Overlay analysis is a method used to compare and integrate different types of spatial data to gain a more comprehensive understanding of an area. In the context of this study, overlay analysis was carried out to assess the suitability of rice fields based on data generated from the Decree of the Ministry of ATR/BPN No. 686 of 2019 and the latest field data. The first step in overlay analysis is the collection and processing of relevant spatial data.

The data used includes a map of standard rice fields in accordance with the Decree of the Ministry of ATR/BPN No. 686 of 2019, the latest land use data, as well as physical data and soil conditions. These maps are then integrated into geographic information systems (GIS) for further analysis. Furthermore, the overlay is carried out by matching the map of the standard rice field with the current land use map. The purpose of this process is to identify differences or changes between the two maps, as well as to evaluate the suitability of the established paddy fields with actual field conditions.

This includes an analysis of areas that may have changed their function or use, as well as areas that show potential to be returned as productive paddy fields. The results of the overlay analysis provide crucial information in determining areas that need improvement or adjustment to ensure that the existing rice fields are in accordance with applicable provisions and are optimal to support food security. This analysis also helps in recommending potential locations that can be further developed to meet the needs of food production in Serdang Bedagai Regency. Overall, overlay analysis plays an important role in supporting data-driven decision-making processes and helping to formulate appropriate strategies for effective and sustainable use of paddy fields. From the results of the analysis carried out by this study, 2 comparative data will be seen to see the suitability between the use of existing rice fields and the spatial pattern plan of the existing area in Serdang Bedagai Regency. For more details, please see the table below.

Tabel. 3 Results of Rice Field Potential Land Overlay Analysis on the Spatial Pattern Plan of Serdang Bedagai Regency

Space Pattern Plan	Area (Ha)		Land Area (Ha)
	Irrigation Rice Fields	Rainfed Rice Fields	
Enter the Forest Area			
Protected Forest Area	207.95	78.21	286.16
Limited Production Forest Area	1.69		1.69
Permanent Production Forest Area	8.13		8.13
Enter the Regional Development Area			
Rural Settlement Areas	1,055.55	77.08	1,132.63
Urban Settlement Areas	513.42	28.20	541.62
Industrial Allocation Area	10.32		10.32
Outside Non-Food Crop Agricultural Areas			
Horticultural Area	918.30	67.70	986.00

Space Pattern Plan	**Area (Ha)**		**Land Area (Ha)**
	Irrigation Rice Fields	Rainfed Rice Fields	
Plantation Areas	211.04	20.64	231.68
Destroy Others			
Water Bodies	25.29	0.32	25.61
Mangrove Ecosystem Area	0.01	0.00	0.02
Aquaculture Fisheries Area	50.33	41.94	92.27
River Boundary	723.65	39.46	763.11
Beyond Administrative Boundaries	68.93	14.85	83.78
Inside the Sustainable Food Crop Area			
Food Crop Area	25,606.59	1,737.37	27,343.97
Total Area (Ha)	**29,401.22**	**2,105.78**	**31,507.00**

Source : Processing Results, 2024

From the table above, the results of the overlay between the existing rice fields and the spatial pattern plan of Serdang Bedagai Regency are shown. The results of the overlay carried out are known that not all existing rice fields in Serdang Bedagai Regency are included in the space utilization zone of the food crop area, it can be said that there are rice fields in Serdang Bedagai Regency that are allocated space outside the food crop area.

The results obtained from this study are to conclude the division of 5 classifications of suitability for space allocation in Serdang Bedagai district such as:

a. The area of rice fields is included in the forest area zone
b. Rice fields are included in regional development zones such as residential areas and industrial areas
c. Rice field area outside non-food agricultural areas
d. Rice field area for other purposes
e. The rice field area is included in the zone of food crops or sustainable food agricultural land.

V. COVER

In this study, a spatial-based rice field correction analysis has been carried out for the determination of rice field raw land based on the Decree of the Ministry of ATR/BPN No. 686 of 2019. The results of the analysis show that there are several differences between the land designated as raw rice fields in the Decree and the actual conditions in the field. The corrections made identified a number of potential lands that were not previously covered by the determination.

A. Conclusion

In conclusion, this study succeeded in identifying and recommending areas that have high potential to be developed as rice fields to support food security in Serdang Bedagai Regency. These

findings emphasize the importance of regular updating and adjustment of spatial data to ensure the accuracy and relevance of land information in policy decision-making.

a. Decrease in Rice Field Area:

Research shows that there is a decrease in the area of rice fields in Serdang Bedagai Regency by 704.90 ha compared to rice field data from the Decree of the Ministry of ATR/BPN No. 686 of 2019. This change is caused by the conversion of land for non-agricultural uses such as housing, industry, and infrastructure.

b. Potential Land Availability:

Serdang Bedagai Regency has the potential for land that can be developed for agriculture, especially rice. Rice fields with good irrigation conditions reached 23,164.33 ha, while land with poor irrigation reached 999.89 ha. There are also rainfed lands and other potential lands such as moors that can be used to support food security.

c. Spatial Data Correction and Validation:

Spatial-based rice field correction using GIS technology shows that there are around 4,645.40 ha of rice fields that have not been mapped in accordance with Decree 686 of 2019. This data validation is important to ensure that the data used in planning and policy truly reflects actual conditions on the ground.

d. Overlay Analysis:

Overlay analysis shows the difference between the raw paddy field data and the latest land use data. This process identifies areas that have changed function and provides important information to update and improve existing paddy field data.

B. Suggestion

The researcher tried to provide suggestions according to the findings obtained both for the local government of Berdang Bedagai Regency and academics. The following are some suggestions given in this study.

a. Increased Supervision and Law Enforcement:

It is necessary to increase supervision and law enforcement against the conversion of rice fields. Local governments and authorities must ensure that regulations on the protection of agricultural land are complied with and involve the community in the monitoring process.

b. Revision and Update of Rice Field Data:

It is recommended that the Decree of the Ministry of ATR/BPN No. 686 of 2019 be updated periodically to accurately reflect changes in land conditions. The use of GIS technology in data updates should be improved to reduce discrepancies between map data and field conditions.

c. Potential Land Development:

Local governments need to prioritize the development and use of potential land that has been identified in this study. This includes rainwatershed, moors, and food crop areas in accordance with the regional spatial plan.

d. Irrigation Infrastructure Improvement:

To support the productivity of paddy fields, the improvement and maintenance of irrigation infrastructure is very important. Local governments need to invest in irrigation systems to

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