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RESEARCH ARTICLE

Evaluation of Settlement Distribution on Detailed Spatial Plan in Sewon District, Bantul Regency, Special Area of Yogyakarta 2018 – 2038

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Abstract Securing a place of settlement is essential for the sustenance of human life and the need increases with population. In Sewon District, Bantul, Indonesia, the development requires monitoring to ensure the consistency of the distribution with spatial pattern plan determined by the local government. Imagery as a remote sensing product processed with GIS can also be used in monitoring the distribution to provide more detailed information regarding land use. Therefore, this research aims to evaluate the distribution of settlement against detailed spatial plan (RDTR) for the Sewon Urban Area (BWP) of Bantul Regency in 2018-2038. Visual interpretation methods of SPOT-7 PMS imagery are used in mapping existing settlement land, field surveys, and GIS processing. The results show that mapping settlement land using imagery produces an accuracy of 95.20%. In addition, settlement land is suitable with and without spatial plan reaching 579.88 hectares or 87.26% and 9.62 hectares or 1.45%. Settlement land temporarily not inconsistent with detailed spatial plan is 75.05 hectares or 11.29% of the total area. In this context, local governments must pay more attention to existing settlement with regular monitoring.

1. Introduction

Evaluation in spatial planning is an assessment activity in realizing the program structure (Ministry of Agrarian and Spatial Planning, 2017) and monitor space use. In this context, the results of land evaluation activities provide information and directions for land use according to needs (Ritung, et al., 2007). According to Indonesian Government Regulation No. 21 of 2021, RDTR is detailed plan regarding spatial layout of the regency/city area equipped with zoning regulations. RDTR is used as a reference in the use of space. In this context, settlement is part of a residential environment consisting of more than one housing unit with infrastructure, facilities, public utilities, and supporting activities for other functions in urban or rural areas (The Republic of Indonesia, 2011). Settlement has a very important position in human needs and is included as one of the primary needs to be met. Existing settlement must be located in line with the land use directions specified in spatial plan. Inconsistency between existing land use and spatial planning causes various problems, such as land degradation, conversion, and fragmentation (Perkasa et al., 2022). This also applies to settlement which causes the impacts when development is not in line with detailed spatial plan.

Sewon District is in Bantul Regency which is a peri-urban zone between urban and rural areas (Yunus, 2009). This can be identified from the location in the transition zone between the urban and rural areas of Yogyakarta and Bantul Regency, respectively. Inconsistencies between land use and detailed spatial plan can be a serious challenge in peri-urban areas. This is because peri-urban areas tend to experience rapid transformation from agriculture to settlement. An example is research conducted by Kurniasih & Rudiarto (2014) where Kartasura District, as a peri-urban area of Surakarta City, Indonesia, experienced land transformation towards urban areas. Several agricultural lands have been converted to non-agricultural use, impacting the decline in production.

Population data from the Central Statistics Agency of Bantul Regency (2021) shows that Sewon District has the highest population density and continues to increase every year. The high population growth can trigger land conversion (Sadali, 2014). The land use change causes an increase in settlement land in peri-urban areas. The increase leads to mismatches in land use for the growth of illegal settlement. Therefore, the distribution of settlement in Sewon District should be evaluated to determine the consistency with spatial pattern plan in RDTR. In this context, RDTR is detailed spatial plan for the Sewon Urban Area (BWP) in 2018 – 2038 which is the current RDTR stipulated in Bantul Regency Regulation No. 8 of 2018 concerning Detailed Spatial Planning and Zoning Regulations of the Sewon BWP 2018-2038.

The use of remote sensing has brought changes in urban research with the ability to provide a comprehensive image of city dynamics. According to Miller & Small (2003), in developing countries, remote sensing can give fundamental observations about urban growth unavailable from other sources. This also applies in Sewon District, Bantul Regency, where limited data regarding the current conditions of regency development can be obtained through the local government. Remote sensing has become a data source used to analyze various urban phenomena. Research on urban areas has been successfully carried out using remote sensing. Panjaitan et al. (2019) evaluated the suitability of land use for regional spatial planning (RTRW with a scale of 1:50,000) in Cianjur

Regency using remote sensing imagery. The imagery used in this research are IKONOS and SPOT-7 imagery. In addition, Utama et al. (2018) carried out a land use evaluation of the regional spatial plan (RTRW) using Landsat 8 imagery to produce recommendations related to existing conditions in the Batur UNESCO Global Geopark. The results show that there are many land uses not in line with the designations regulated in spatial plan. In this context, remote sensing can assist in the land use evaluation process to evaluate settlement in the Sewon District. This research is different from Panjaitan et al. (2019) and Utama et al. (2018) regarding the focus on land use, the type of image used, and the scale of spatial plan. Additionally, it was conducted in Sewon District with a focus on evaluating settlement using SPOT-7 Pan-sharpened (PMS) imagery and RDTR with a scale of 1:5000. Settlement evaluation had greater detail since SPOT-7 Pan-sharpened (PMS) imagery with a resolution of 1.5 meters and Detailed Spatial Plan with a scale of 1:5000 were used. Meanwhile, SPOT-7 PMS imagery is selected because the imagery is high-resolution and can be easily accessed through the National Institute of Aeronautics and Space (LAPAN).

Geographic Information Systems (GIS) have become a tool in urban research. GIS is popular because of the ability to conduct complex spatial analysis to understand various urban dynamics. According to Shafa & Kosovrati (2015), the use of GIS in city planning helps planners in developing settlement and urban infrastructure facilities. GIS is also an important tool in decision-making related to land use (Shafa & Kosovrati, 2015). There are different types of analysis tools in GIS used in urban research. Panjaitan et al. (2019) conducted land use classification using the manual on-screen digitation classification method. Rahmani & Sukojo (2023) reported that the classification of land use was performed using Object Based Image Analysis (OBIA) and on-screen digitation. In this research, the manual on-screen digitization classification method was selected to produce more settlement land information compared to digital image interpretation. The use of GIS is an easy method to evaluate the distribution of settlement to RDTR by using overlay. This analysis was also used by Panjaitan et al. (2019), Utama et al. (2018), and Rahmani & Sukojo (2023) in the process of evaluating land use. This analysis includes overlapping different spatial data from an area with different attributes (Zhao, et al., 2019). GIS provides significant benefits for remote sensing image processing by producing map-guided classification, increasing accuracy, and post-classification sorting (Zhou, 1995) to facilitate evaluation process. Therefore, this research used remote sensing data from SPOT-7 PMS imagery, which were processed through GIS overlay method to assist settlement evaluation process.

This research aims to (1) determine the ability of SPOT-7 PMS imagery and the level of accuracy in mapping existing settlement land in Sewon District, (2) evaluate the distribution of settlement against Detailed Spatial Planning (RDTR) of BWP Bantul Regency 2018-2038. Policymakers can use the result as a reference to monitor and formulate policies related to settlement in Sewon District, Bantul Regency. In addition, this research is expected to assist the development of remote sensing technology and GIS methods in evaluating the distribution of settlement on the RDTR.

2. Methods

The location is in Sewon District, consisting of 4 villages or sub-districts, namely Pendowoharjo, Timbulharjo, Bangunharjo, and Panggungharjo. Based on astronomical location, Sewon District is at 110°19'18" - 110°22'55" E and 7°49'26" - 7°53'16" S in the geographic coordinate system. The location is directly adjacent to the city of Yogyakarta, affecting the number and density of the population. Therefore, Sewon District was selected as the research location to evaluate the existing settlement.

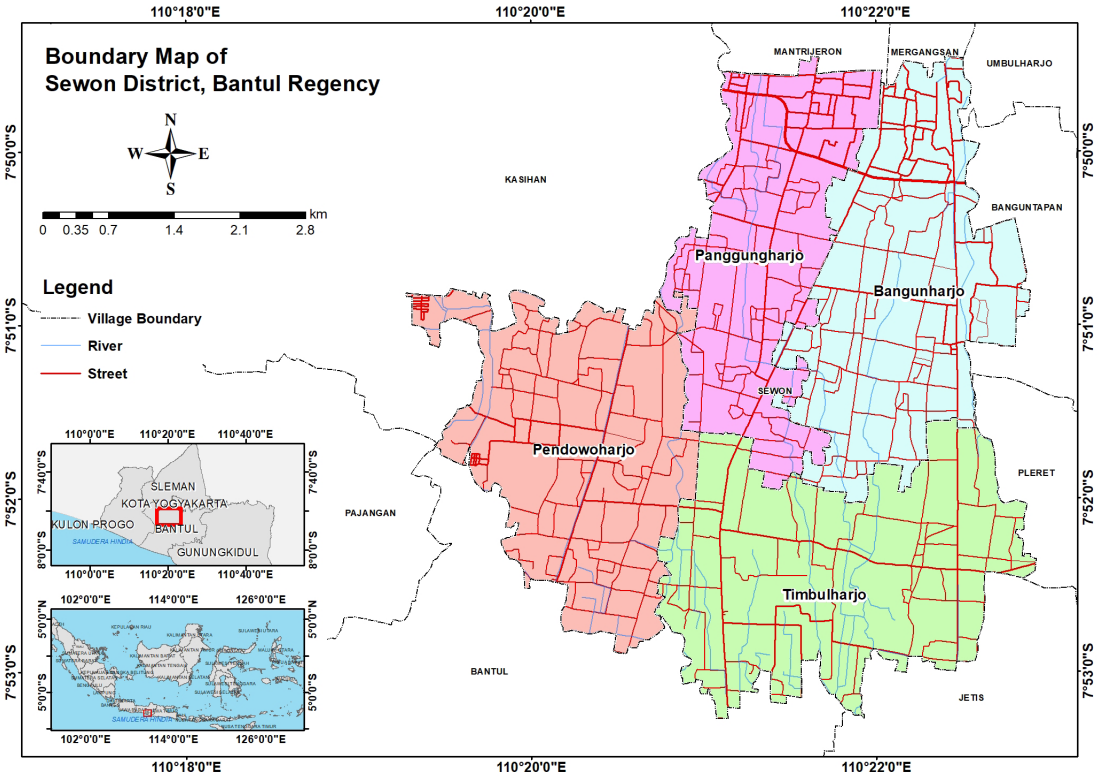

Figure 1. Boundary Map of Sewon District, Bantul Regency, Indonesia

Table 1. Research Data

No.	Data	Source	Data Type
1	SPOT-7 PMS Imagery	National Institute of Aeronautics and Space (LAPAN)	JPEG 2000 (.JP2)
2	Sewon District Boundary	Department of Land and Spatial Planning (Dinas Pertanahan dan Tata Ruang) Bantul Regency	Shapefile (.shp)
3	RDTR (Detailed Spatial Plan)	Department of Land and Spatial Planning (Dinas Pertanahan dan Tata Ruang) Bantul Regency	Shapefile (.shp)

Table 2. SPOT-7 Imagery Specification

Spectral Resolution	Spatial Resolution	Radiometric Resolution	Temporal Resolution
Panchromatic (0.45-0.745 μm)	1.5 meters	12 bits	26 days
Blue (0.450-0.520 μm)	6 meters	12 bits	26 days
Green (0.530-0.590 μm)	6 meters	12 bits	26 days
Red (0.625-0.695 μm)	6 meters	12 bits	26 days
NIR (0.760-0.890 μm)	6 meters	12 bits	26 days

Source: Airbus Intelligence (2021)

Table 3. Evaluation classification

Evaluation classification	Explanation
In line with RDTR	The existing settlement land is in the housing designation zone determined in RDTR.
Temporarily inconsistent with RDTR	The existing settlement is in a cultivation zone other than the housing designation zone determined in RDTR.
Inconsistent with RDTR	The existing settlement is in a protected zone determined in RDTR.

The SPOT-7 imagery is a high-resolution remote sensing satellite image with panchromatic and multispectral images of resolution up to 1.5 and 6 meters, respectively. The image used in this research is the SPOT-7 Fused (Pansharpened/ PMS) with a true color composite and 1.5 meters spatial resolution. The imagery was acquired on March 3, 2021, to obtain information on the use of existing settlement land. The use of imagery is based on the need for high resolution to assist in the use of the visual interpretation process in manual on-screen digitization classification to obtain settlement land information. The sharpened SPOT-7 imagery has a high spatial resolution of up to 1.5 meters and the imagery is considered capable of providing good information about settlement land. The concept helps the visual interpretation process in manual on-screen digitization classification. In addition, SPOT-7 imagery is satellite imagery with the highest spatial resolution obtained through the National Institute of Aeronautics and Space (LAPAN) for research purposes, as reported in Table 2.

The types of settlement interpreted in this research are horizontal, where a plot of land with a certain area only consists of one house unit occupied by a family (Setiawan, 2013). The results of the distribution map will be verified directly in the field and the field survey will be reinterpreted. Verification of the results is carried out using an error matrix to determine the level of accuracy of the mapping results, which produces kappa accuracy. In this research, the minimum accuracy value used is 85%, and this is related to land use interpretation set by Anderson (1971). An accuracy value of at least 85% is used for further analysis. Meanwhile, the kappa coefficient value of 0.8 - 1 is a very high category and the results of the accuracy test on the classification can be trusted (Landis & Koch, 1977).

Evaluation of existing settlement land is conducted by an overlay process between visually interpreted settlement land data with spatial pattern plan in the 2018-2038 BWP Sewon RDTR obtained from the Bantul Regency Land and Spatial Planning Service. In this context, the overlay method was carried out using the intersect tool in ArcMap 10.4 software to compare two spatial data. Therefore, the use is often found in research related to evaluation of spatial planning as reported by Utama et al. (2018) and Rahmani & Sukojo (2023).

Evaluation of settlement land is part of spatial use and the level of suitability relating to the embodiment of the pattern. This process shows the consistency of settlement land with spatial pattern plan regulated in RDTR, as seen in Table 3. Evaluation is achieved using the overlay process method. Therefore, only part of the area is considered when some areas of a polygon are not consistent with RDTR spatial pattern plan. The area calculation for each classification is obtained using the ArcMap geometry tool on the overlay processing between the existing settlement map and RDTR.

The results of evaluation can be used as settlement land regulated in detailed spatial planning in line with RDTR. In this process, the tool used is removed to delete land designated for settlement yet to be used as settlement. The results serve as a recommendation map for settlement development and the research method can be seen in the flow chart (Figure 2).

3. Results and Discussion

Results

The mapping of settlement was carried out using a manual on-screen digitization classification method on SPOT-7 PMS imagery. This imagery has been subjected to the pansharpening process to obtain a 1.5-meter spatial resolution. The results of mapping are settlement map showing the location in Sewon District. The accuracy of the mapping should be tested before being used for settlement evaluation. The accuracy test was carried out using an error matrix and the results can be seen in Table 4.

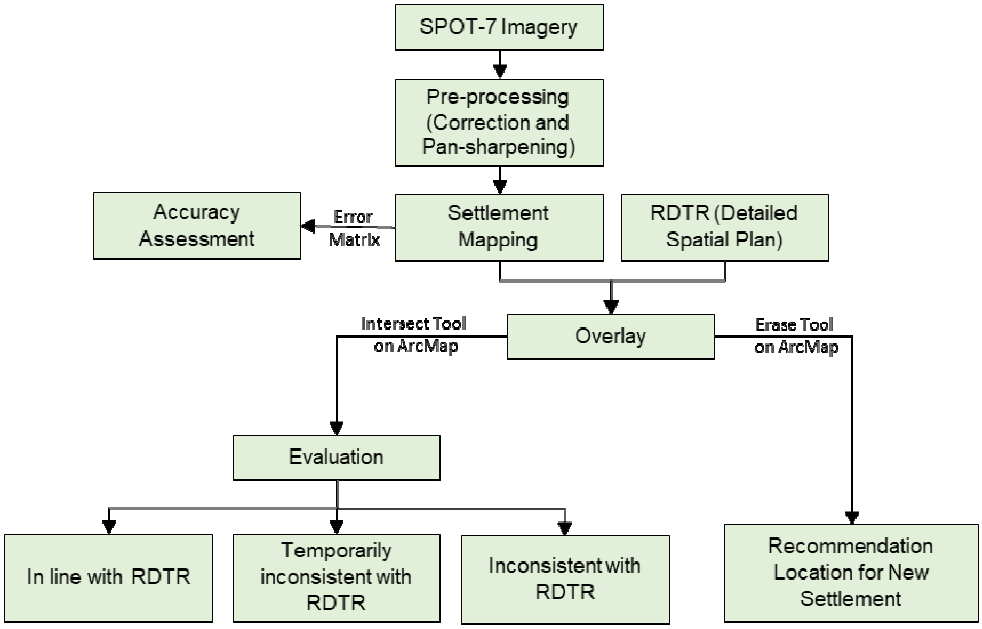

Figure 2. Research Flowchart

Table 4. Error Matrix

Accuracy		Field		Total Row	User Accuracy	Commission Error
		Settlement	Non-Settlement			
Interpretation	Settlement	272	16	288	94.44	5.56
	Non-Settlement	1	65	66	98.48	1.54
Total Column		273	81	354		
Producer Accuracy		99.63	80.25		**Overall Accuracy**	95.20%
Omission Error		0.34	19.75		**Kappa**	0.85

Figure 3. Agreement between imagery interpretation (left) and field (right)

Figure 4. Difference between imagery interpretation (left) and field (right)

The accuracy test was carried out using an error matrix with 354 samples verified through a field survey. The results show that there is agreement and difference between interpretations of classes and existing land use. An example of agreement can be seen in Figure 3 which shows the agreement of interpretation in the imagery and field as settlement classification. Figure 4 shows the image interpreted as settlement and the field survey represents farm building.

The calculation of the accuracy test with the error matrix produces some information, including overall, kappa, user, and producer accuracy. Overall accuracy shows the percentage of the analytical unit classified correctly. Meanwhile, kappa

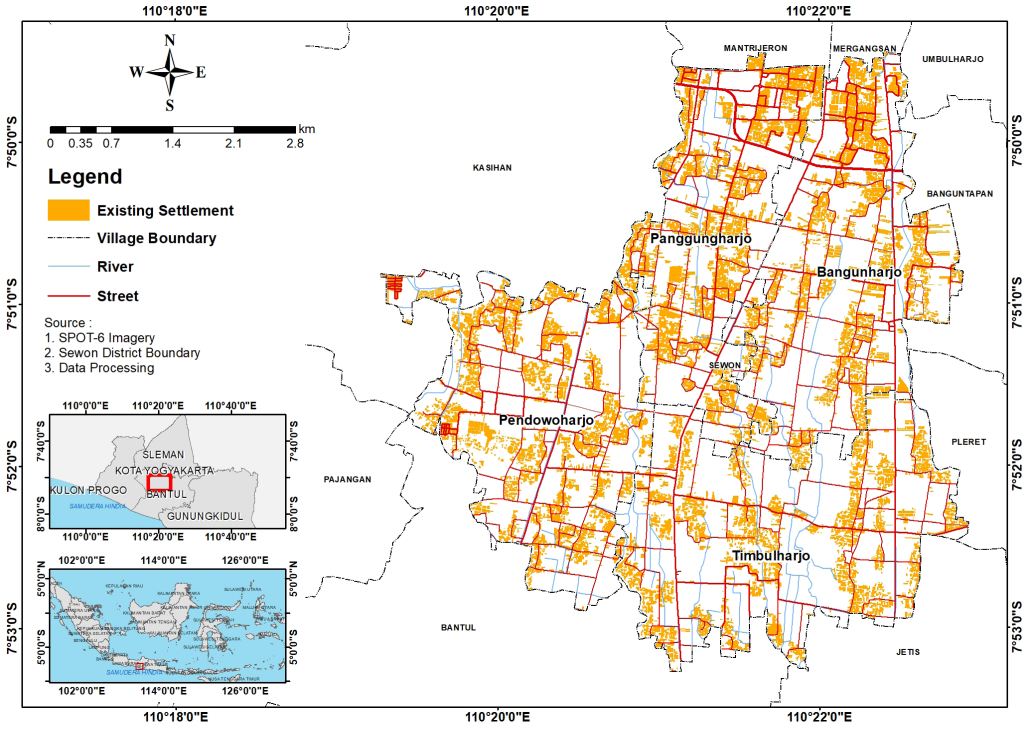

Figure 5. Map of the Distribution of Settlement in Sewon District

Table 5. Existing Settlement Area

Village	Settlement Area (hectares/ha)
Pendowoharjo	167.59
Timbulharjo	156.39
Bangunharjo	165.57
Panggungharjo	175.01

accuracy represents the percentage of image classification. The mapping results can be used for further analysis when the resulting accuracy has met the minimum requirements in the interpretation of land use and cover at 85% (Anderson, 1971). The error matrix calculation represents overall and kappa accuracy values of 95.20% and 0.85, respectively. A high value of kappa accuracy shows that the test on the classification can be trusted (Landis & Koch, 1977). Overall accuracy is expected to meet the specified minimum requirement of 85% to be continued for further analysis.

The largest existing settlement area is in Panggungharjo Village, which is 175.01 hectares as reported in Figure 5 and Table 5. Compared with the area of Panggungharjo Village with 569.97 hectares, settlement has a percentage of 30.7%. Panggungharjo has a strategic location compared to others in Sewon District, which is directly adjacent to the city of Yogyakarta. In addition, this village is also passed by several major roads, including the Yogyakarta Ring, Bantul Street, and Parangtritis Street. The existence of major roads and strategic locations improves accessibility and attractiveness of the location.

The result of interpretation shows that Kelurahan Pendowoharjo has settlement area and RDTR of 167.59 and 704.05 hectares, respectively. The percentage of settlement area is 23.80% of Pendowoharjo Village. The area is wider than Bangunharjo and Timbulharjo but not directly adjacent to the city of Yogyakarta since villages are also passed by Bantul and Parangtritis Streets.

Based on the results of interpretation (Table 5), Bangunharjo Village has an existing settlement area and RDTR of 165.59 and 714.95 hectares, respectively. Settlement area is 23.16% of the area of Bangunharjo Village. Similar to Panggungharjo, Bangunharjo is also directly adjacent to Yogyakarta City. These villages are passed by the Yogyakarta Ring Road, but the difference is Parangtritis and Imogiri Barat Streets. Therefore, the area tends to be less crowded than the area flanked by Parangtritis and Bantul Streets.

The results show that Timbulharjo Village has an existing settlement area and RDTR of 156.39 and 806.10 hectares, respectively. Settlement area is the smallest compared to other urban villages, which is 19.4%. The interpreted map shows that the area is dominated by non-settlement land. This can be caused by the distance to the city of Yogyakarta which is further than other villages.

There are different kinds of land use designations in Sewon District based on RDTR BWP Sewon in 2018 – 2038. These land uses include housing, local protection, green open space, cultural heritage, trade and services, offices, public service facilities, special services, mining, and tourism. Evaluation process is carried out using the map of the distribution of settlement obtained previously, as reported in Figure 5. The map classifies land use into settlement and non-settlement classes because evaluation focuses on only settlement land. Evaluation of the existing settlement land on the RDTR is carried out with the village analysis unit to determine the suitability of spatial pattern plan determined by the local government.

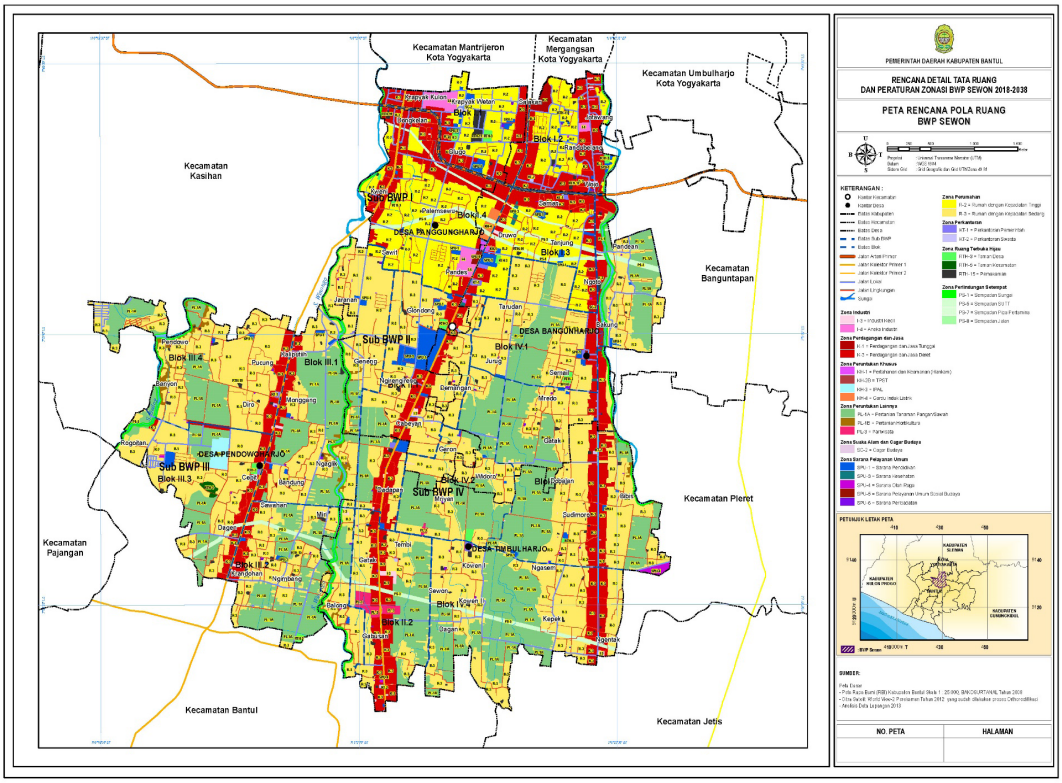

Figure 6. Spatial Pattern Map of RDTR for the BWP of Bantul Regency in 2018-2038

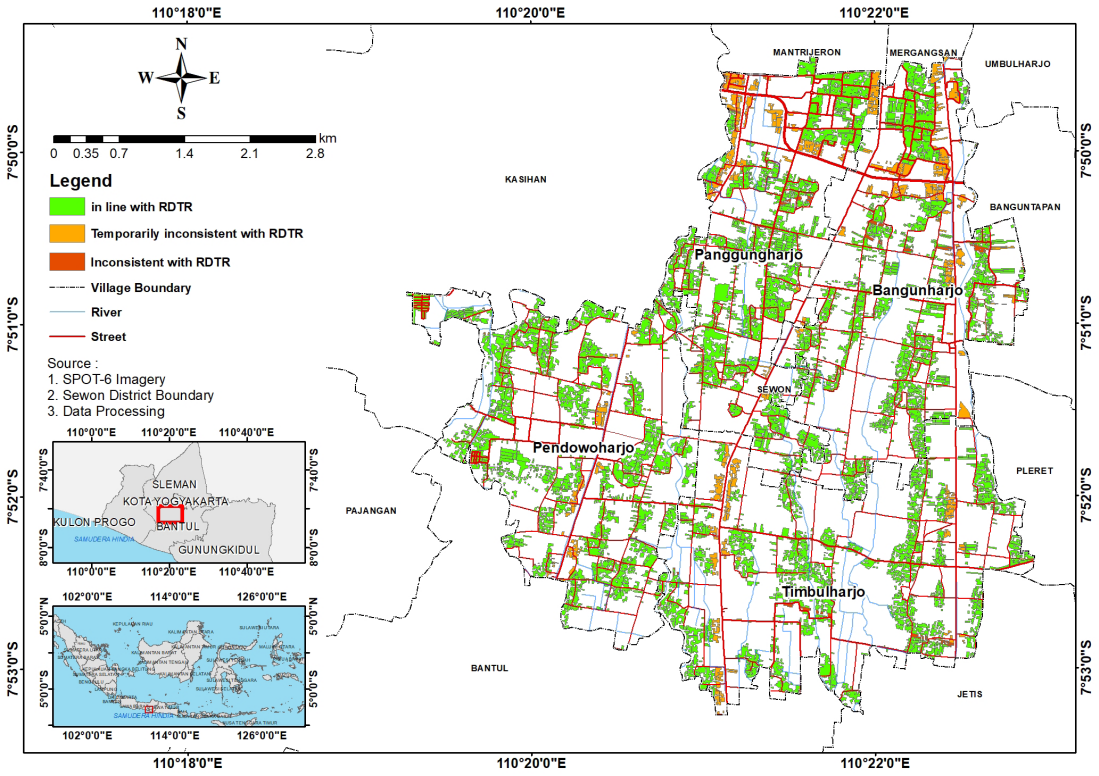

Figure 7. Evaluation Map of the Suitability of Existing Settlement to RDTR

Table 6. Area of the Suitability of Existing Settlement to RDTR

Classification	Area (hectares/ha)			
	Pendowoharjo	Timbulharjo	Bangunharjo	Panggungharjo
In line with RDTR	158.37	137.30	135.64	148.56
Temporarily inconsistent with RDTR	8.76	16.64	25.82	23.84
Inconsistent with RDTR	0.46	2.45	4.11	2.61

Evaluation results can be seen in Figure 7 and Table 6, where villages in Sewon District still have settlement land not consistent with RDTR. Bangunharjo is the village with the lowest level of suitability. The settlement in line with RDTR spatial plan is 135.64 hectares or 81.92%, while the inconsistent area is 4.11 hectares or 2.48%. The area of settlement temporarily inconsistent with RDTR reaches 25.82 hectares or 15.59% in Bangunharjo Village. Meanwhile, Pendowoharjo has the highest level of suitability. The existing settlement in line with RDTR spatial plan is 158.37 or 94.50%, while the inconsistent area is 0.46 hectares with a percentage of 0.27%. The settlement temporarily inconsistent with RDTR is 8.76 hectares or 5.23% of the total area in Pendowoharjo Village. Settlement land in line with RDTR spatial pattern plan is 579.88 hectares, or 87.26%, while the inconsistent area with RDTR is 9.62 hectares or 1.45%. Settlement land temporarily inconsistent with RDTR is 75.05 hectares or 11.29% of the total area in Sewon District. Figure 8 shows the percentage of the suitability of settlement land in each village.

Discussion

Based on these results, most of settlement land in Sewon District is in line with spatial pattern plan set in RDTR BWP Sewon 2018 - 2038. The distribution of settlement land evaluation can be seen in Figure 7. The results of evaluation show that settlement is inconsistent with RDTR. This is due to the large number of existing settlement land located in cultivation zone areas. Even though the area is inconsistent

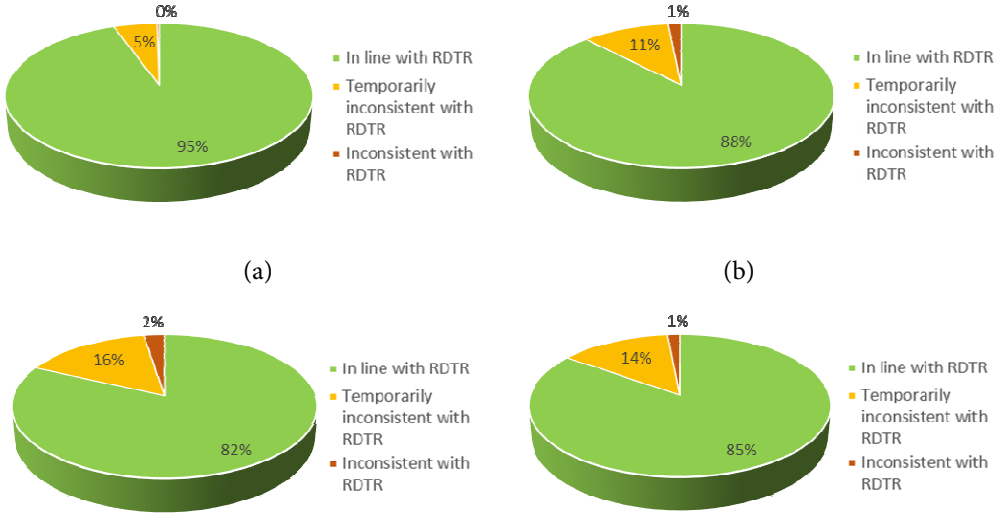

Figure 8. Settlement Evaluation Percentage in (a) Pendowoharjo Village, (b) Timbulharjo Village, (c) Bangunharjo Village, and (d) Panggungharjo Village

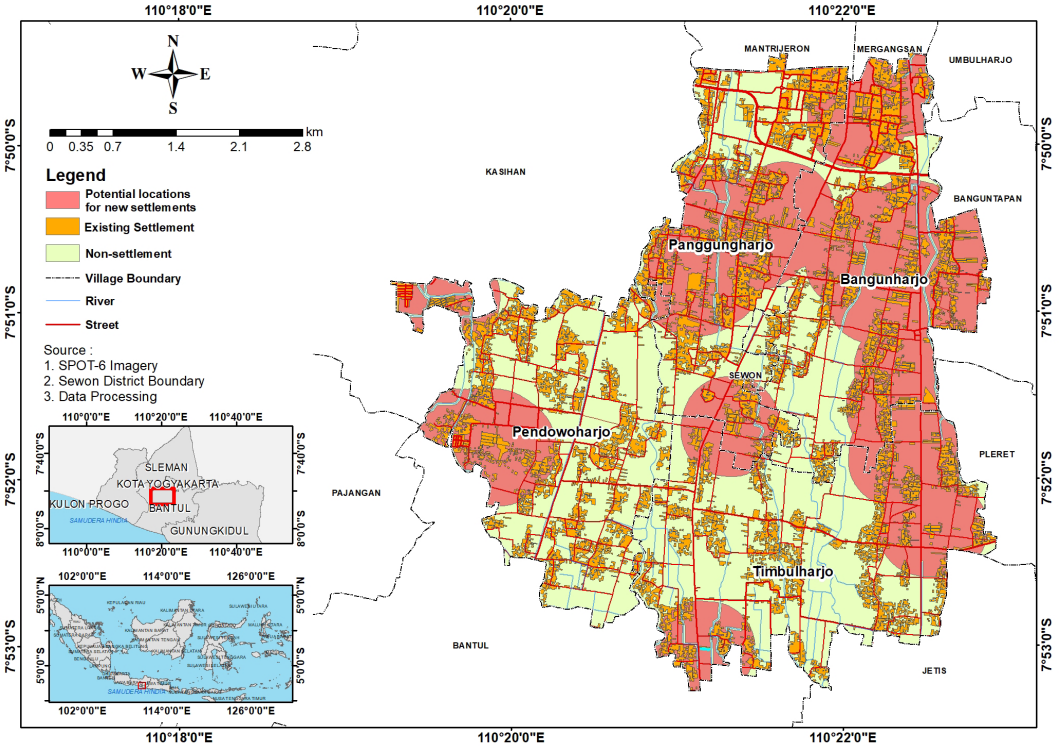

Figure 9. Map of The Potential for Additional Housing Estate By Developers

with RDTR, settlement land in cultivation zones is still possible to become suitable with RDTR when there is a change in spatial pattern planning monitoring process. In contrast, settlement land is located in a protected zone classified as inconsistent with RDTR. Even though the area is very small, the land needs local government supervision. Settlement should not be allowed to continue when left unchecked to prevent the development of new area that are not in line with the existing plan.

Inconsistent settlement land with RDTR is located in a protected area influenced by various economic factors, such as high land prices and the limited financial capacity of the community to accommodate good housing. Pamungkas (2016) analyzed changes in land prices in Sewon District between 2009 to 2014. Therefore, there has been an increase in prices due to the development of settlement land and the addition of drinking water pipe network utilities. Pamungkas (2016) also reported that changes in land prices were influenced by the distance of Sewon District from Yogyakarta City. The low economic capacity of the community plays a role in the development of settlement in undesignated locations. Meanwhile, low economic capacity causes the community to build settlement with makeshift conditions (Sari & Ridlo, 2021), specifically in the river border area.

Another factor responsible for the non-compliance of settlement land with RDTR in Sewon District is suboptimal supervision in implementing detailed spatial plan. Since detailed spatial plan is strengthened as a regional regulation (Bantul Regency Regional Regulation No. 8 of 2018), non-compliance with the existing settlement is a violation of legal regulations. However, there has been no firm action from the local government in addressing violations of the use of settlement inconsistent with the designation. The failure to implement spatial plan can cause various problems when continuously ignored.

The suitability of settlement land can change in the future due to increased population and need for housing. This was supported by data obtained from the Population and Civil Registry Office of Bantul Regency (2021), where the population in Sewon District continued to increase over the past 5 years. The observations through SPOT-7 imagery also report that housing estates are widely located in Sewon District. Therefore, an analysis of potential locations for housing was carried out to provide insight to the local government in conducting supervision.

Existing housing has been equipped with facilities and infrastructure used by other developers to build settlement. Therefore, the analysis was carried out by overlaying housing data obtained from the interpretation of SPOT-7 imagery, as well as road and river buffers using GIS. Existing housing estates, roads, and rivers are used as the basis for determining locations with potential expansion.

The analysis can be seen on the map of the potential for additional housing estate by developers, as reported in Figure 9. These results show that several areas possess the potential to become locations for a housing estate. The location requires more attention from the local government to ensure the increase in settlement is consistent with the designation determined in RDTR spatial pattern plan. This needs to be achieved to prevent an increase in the level of settlement land that is not consistent with RDTR.

Based on spatial pattern plan determined in RDTR, a map of the location of the recommendation for additional land can be obtained. This shows locations used for settlement land in line with spatial plan of the Sewon RDTR. Spatial pattern is prepared by the local government according to the land capacity. Therefore, settlement development should be adjusted to the designation zone in the existing spatial pattern plan. In this context, communities and developers are expected to select a location on the map to build settlement.

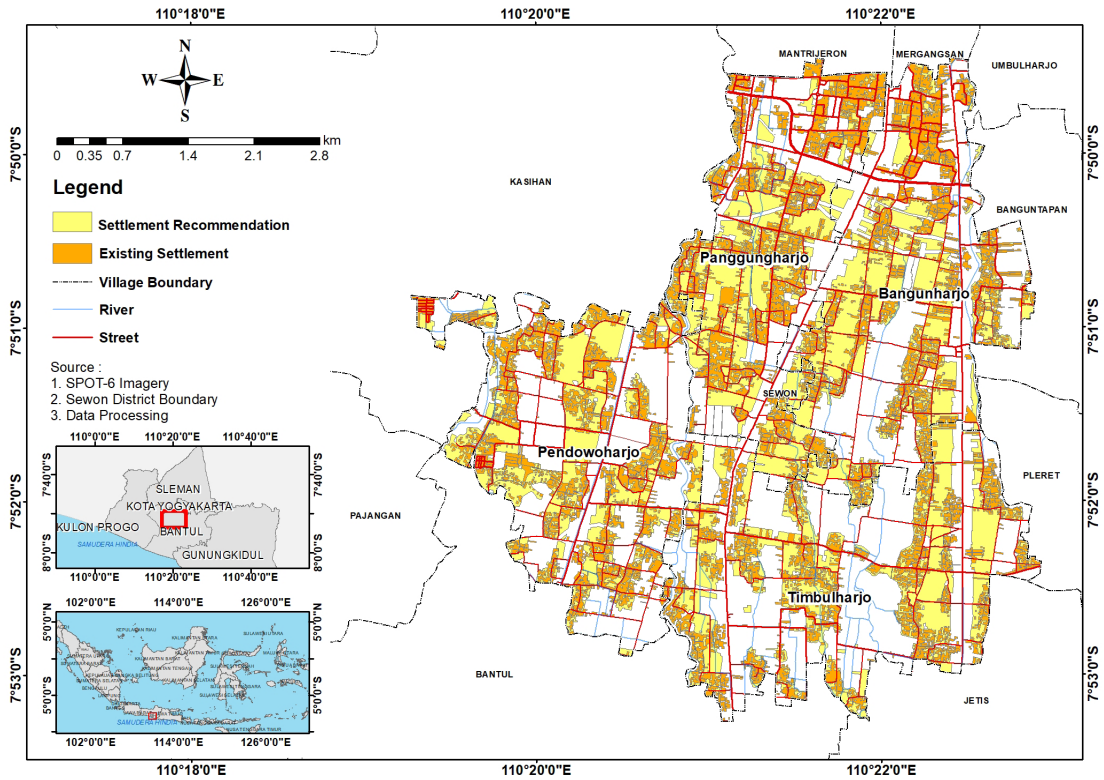

Figure 10. Map of Recommended Locations for Future Settlement Areas in Sewon District

The limitations of this research include several important aspects. First, the analysis used is sourced from SPOT-7 imagery data and the actual conditions have not been identified in the interpretation process. Second, the research only considered horizontal settlement in evaluation process. Further analysis with imagery data and spatial resolution is expected to overcome these limitations and provide deeper insights into the phenomena by considering various types of settlement.

4. Conclusion

In conclusion, evaluation of the distribution of settlement in Sewon District showed that most of the land in Sewon District was in line with RDTR at 579.88 hectares or 87.26%. Settlement inconsistent with RDTR was 9.62 hectares or 1.45%, while area temporarily in line with the variable was 75.05 hectares or 11.29%. Therefore, local governments were expected to pay attention to existing settlement inconsistent with planned spatial pattern RDTR to prevent expansion.

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