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Impact of the designation of Ciletuh-Palabuhanratu UNESCO Global Geopark (CPUGGp) on space utilisation in Ciemas District, Sukabumi Regency, Indonesia

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ABSTRACT

The designation of Ciemas District as part of the Ciletuh-Palabuhanratu UNESCO Global Geopark (CPUGGp) has had an impact on land-use changes. Ciemas District has become a new growth center that attracts and increases the number of visitors. Therefore, land-use must be in harmony with spatial patterns and provide protection for its primary function as a conservation area. The objectives of this research are: 1) To analyze land-use changes in Ciemas District after the designation of the CPUGGp; 2) To predict land-use changes until the year 2043; 3) To analyze the suitability of land-use with the Regional Spatial Plan (RTRW) of Sukabumi Regency for the years 2023–2043 in Ciemas District; and 4) To formulate directions for improving the Spatial Pattern of the RTRW of Sukabumi Regency. The data analysis techniques consist of land-use change analysis using GIS overlay and land-use prediction using CA-Markov. The results of the land-use/land cover change analysis for the 2015–2019 period show that an area of 23,912.16 Ha (75%) remained unchanged, while an area of 8,006.54 Ha (25%) changed. The land-use/land cover change for the 2019 to 2023 period shows that an area of 30,893.63 Ha (97%) remained unchanged, and an area of 1,025.52 Ha (3%) changed. The land-use prediction for the year 2043 is dominated by Open Land and Plantations. Residential areas and Activity Centers continue to increase, while Forested Areas continue to decrease. The alignment of land-use with the RTRW Spatial Plan shows results of 77.14% consistent, 4.86% transitional, and 11.85% inconsistent. The directions for improving the RTRW Spatial Plan are to continue appropriate land-use/land cover, direct transitions to align with the RTRW Spatial Plan, and address inconsistencies, particularly in existing Settlements and Activity Areas (Tourism and Industry), to be accommodated in the upcoming revision process of the Sukabumi Regency RTRW Spatial Plan.

Keywords: *CA-Markov; conservation area; destination; land-use prediction; spatial pattern improvement.*

INTRODUCTION

Ciletuh–Palabuhanratu has been designated as a UNESCO Global Geopark (UGGp), reflecting its exceptional geological heritage, scenic beauty, and scientific significance. Initially designated as a national geopark in 2015, the area covered the districts of Ciemas and Ciracap. Following an advisory mission, the geographical coverage of the geopark was expanded to encompass eight sub-districts as part of the process of upgrading its status to a global geopark (Putri, 2019). In 2018, Ciletuh–Palabuhanratu was officially recognized as a UNESCO Global Geopark in Sukabumi Regency, West Java, Indonesia. A geopark is a geographically defined area characterized by sites of significant geological heritage and managed through an integrated approach to conservation, education, and sustainable development. Beyond geological features, a geopark encompasses biological and cultural diversity within clearly defined geographical boundaries, promoting synergies among geological heritage, biodiversity, and local cultural values.

Geoparks represent an approach to the sustainable use and management of areas with significant natural heritage, offering opportunities to promote sustainable regional development. Their development is generally guided by three main pillars: conservation, education, and the improvement of local community welfare (Fajar et al., 2023). Ciletuh–Palabuhanratu UNESCO Global Geopark covers approximately 126,100 ha (1,261 km²), encompassing 74 villages across eight sub-districts: Ciracap, Surade, Ciemas, Waluran, Simpenan, Palabuhanratu, Cikakak, and Cisolok. The geopark is divided into three geoareas: Ciletuh, Simpenan, and Cisolok. Following its designation and the increased attention it has received from the government, the development of the Ciletuh area has contributed to its emergence as a new growth center in West Java, particularly within Sukabumi Regency.

The designation of Ciletuh–Palabuhanratu as a UNESCO Global Geopark has influenced the direction of regional development, particularly in areas located within the geopark. The West Java Provincial Government has positioned the geopark as a strategic initiative for developing its potential as a world-class tourism destination. Infrastructure development, particularly improvements in accessibility and

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connectivity, has become an important component of this process, facilitating travel to and within the geopark. Guided by the motto "Celebrating Earth Heritage, Sustaining Local Communities," the geopark seeks to integrate geological heritage conservation with local socioeconomic development. Increasing tourist arrivals may stimulate economic activities and generate income opportunities for local communities, particularly through the development of accommodation facilities and micro, small, and medium-sized enterprises (MSMEs). However, tourism-driven development may also intensify pressure on land resources and influence spatial utilization, potentially resulting in changes in land-use patterns.

The development of Ciletuh–Palabuhanratu UNESCO Global Geopark has had implications for regional development, particularly in Ciemas District, which has emerged as a new growth center in Sukabumi Regency. According to Perroux's (1950) growth pole theory, economic growth tends to concentrate around particular centers of activity and may generate broader spatial and economic transformations in surrounding areas. In the context of Ciemas, the expansion of tourism-related activities and supporting infrastructure may influence the distribution and intensity of land use. Yudhistira et al. (2021) reported a substantial increase in tourist arrivals following the geopark's development and designation as a UNESCO Global Geopark. Tourist visits increased by 154.11% between 2012 and 2019. The highest recorded number of visits occurred in 2018, reaching 1,175,258 visitors, coinciding with the designation of Ciletuh–Palabuhanratu as a UNESCO Global Geopark. This growth in tourism highlights the potential for geopark development to stimulate regional economic activity while also increasing demand for land for tourism facilities, transportation infrastructure, settlements, and other supporting activities.

Ciemas District has consequently become an increasingly attractive destination for visitors, accompanied by the expansion of infrastructure, particularly accessibility and tourism amenities. Research by Yuda and Yulianti (2024) indicates that the designation of Ciletuh–Palabuhanratu as a UNESCO Global Geopark has brought substantial changes compared with the conditions prevailing before its designation. These changes have affected several sectors, including infrastructure, the local economy, and education. Nevertheless, the extent to which these developments have altered land-use patterns, whether the resulting land-use changes are consistent with the regional spatial planning framework, and how future changes may affect spatial planning objectives require further investigation.

Against this background, this study aims to: (1) analyze land-use changes in Ciemas District following the designation of Ciletuh–Palabuhanratu UNESCO Global Geopark (CPUGGp); (2) predict future land-use changes up to 2043; (3) assess the conformity of existing and projected land use with the 2023–2043 Regional Spatial Plan (Rencana Tata Ruang Wilayah, RTRW) of Sukabumi Regency; and (4) formulate recommendations for refining the spatial pattern provisions of the Sukabumi Regency RTRW. By examining historical land-use changes, projecting future spatial dynamics, and evaluating their conformity with regional spatial planning, this study is expected to provide an evidence base for more integrated spatial planning and sustainable regional development in Ciemas District.

METHODS

Research Location

The research was conducted in the Ciemas District, Sukabumi Regency, as part of the Ciletuh Palabuhanratu UNESCO Global Geopark (CPUGGp). The area of Ciemas District is 31,919 Ha, geographically located between 7° 16' 46.431" and 7° 8' 54.701" S and between 106° 29' 48.321" and 106° 23' 14.481" E. The research location map is presented in Figure 1.

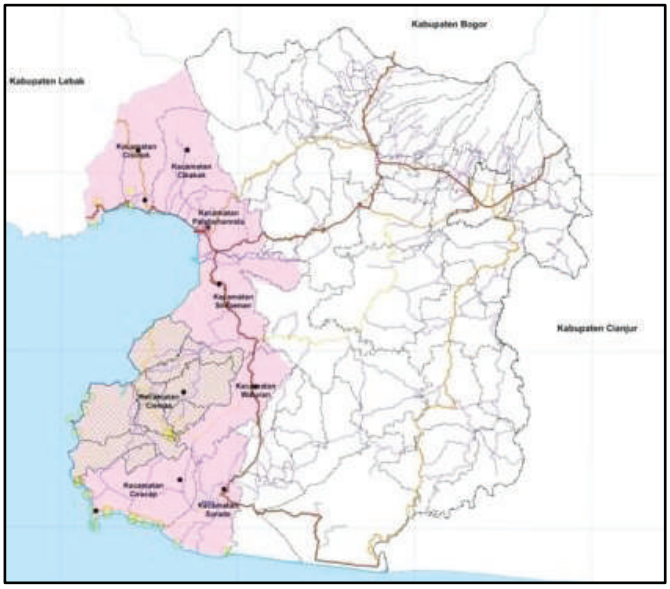


Figure 1. Research location in the Ciemas District, Sukabumi Regency, West Java, Indonesia.

Data Collection Techniques

Data collection was carried out using two methods. Secondary data in the form of land-use data from 2015 and 2019 sourced from the Sukabumi Regency Spatial Planning and Land Agency, and SPOT 6 satellite imagery from 2023 sourced from the National Research and Innovation Agency. Subsequently, field checks were conducted for each land-use at two different points to validate the interpretation results of the SPOT 6 imagery from 2023. Data collection data analysis techniques for each research objective are listed in Table 1.

Table 1. Data collection and data analysis techniques.

Objectives	Data Collection Techniques	Data Analysis Techniques
1. Analyzing land-use changes in Ciemas District after the designation of Ciletuh Palabuhanratu UNESCO Global Geopark (CPUGGp).	Secondary data survey Primary data survey (observation, interview, documentation)	Gap analysis with map overlay
2. Making predictions about land-use changes until the year of 2043	Result of the first objective	Cellular Automata - Markov
3. Analyzing the alignment of land-use with the regional spatial planning (RTRW) of Sukabumi Regency for the years 2023-2043 in Ciemas District	Secondary data survey	Gap analysis with map overlay
4. Preparing guidelines for the improvement of the Spatial Pattern of the Regional Spatial Plan for Sukabumi Regency	Data on land-use alignment with the RTRW spatial pattern	Gap analysis with map overlay

Data Analysis Techniques

Land-use Change Analysis

The data analysis technique consists of land-use change analysis using GIS overlay of land-use maps from 2015 to 2019, from 2019 to 2023 to identify the change patterns. The stages of land-use change analysis are presented in Figure 2.

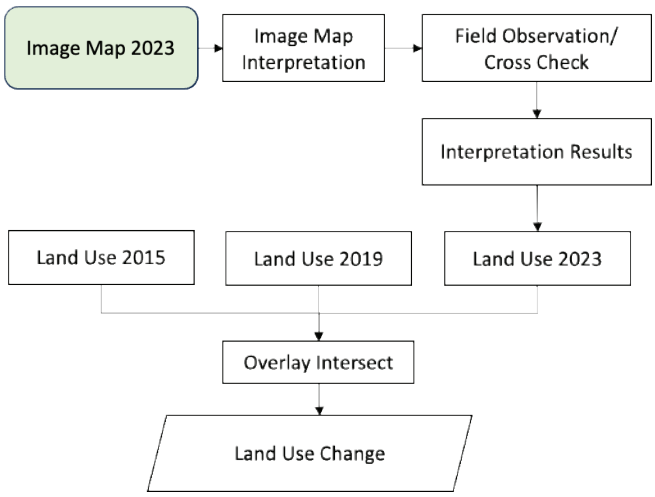


Figure 2. Flowchart of land-use change analysis.

Land-use Prediction Analysis

Land-use prediction is used to estimate land-use in 2043 based on the consideration that 2043 marks the end of the Regional Spatial Planning of Sukabumi Regency. The analysis was conducted using the Markov Chain and Cellular Automata (CA) methods with the IDRISI Selva software. The use of the CA-Markov method in land-use change has many advantages, including dynamic simulation capabilities, advantages in data scarcity and direct field calibration, as well as the ability to simulate several complex land-use patterns (Hyandye & Martz, 2017). Many studies have applied the CA-Markov model to monitor and assess land-use changes and predictions (Aji et al., 2019). The data validation method that can be used is Kappa, with the minimum accuracy criteria achieved presented in Table 2. If the simulation results have a strong Kappa value, then modeling for prediction can be carried out for the desired target year. The process of land-use prediction analysis is illustrated through the diagram in Figure 3.

Table 2. Minimum criteria for Kappa Coefficient Value.

Kappa Coefficient Value	Kappa Value Interpretation
<0.20	Poorr
0.21-0.40	Fair
0.41-0.60	Moderate
0.61-0.80	Good
>0.80	Very Good

Source: Kunz (2017)

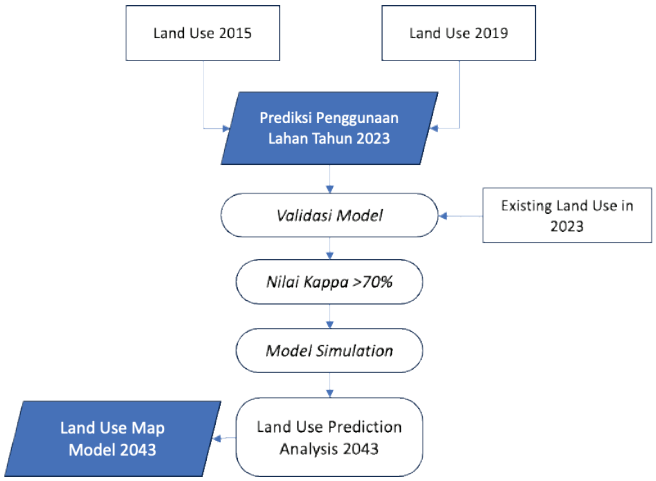


Figure 3. Flowchart of land-use change prediction analysis.

Analysis of Land-use Compatibility with RTRW Spatial Patterns

The analysis was conducted using two types of data namely existing land-use data for the year 2023 and predicted land-use data for the year 2043, with the Spatial Pattern of the Regional Spatial Planning (RTRW) of Sukabumi Regency. This analysis uses ESRI ArcGIS 10.8 software with the Geoprocessing extension, employing the overlay intersect in the analysis tools toolboxes (Sejati et al., 2020).

The classification of alignment consists of 3 categories: consistent, transitiona, and in consistent, based on considerations of land-use types that are difficult or impossible to change, both in terms of cost and effort required, as well as the social issues that may arise (Dani et al., 2017). Harmonious land-use refers to the existing land-use that aligns with the spatial plan directives of the RTRW. Transitional land-use refers to the existing land-use that does not yet align with the spatial plan but still has the potential to be harmonized.

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For example, if in the spatial plan it is designated for residential use but in the field it is still open land or not yet built. Non-aligned land-use means the existing land-use differs from the RTRW spatial plan and cannot be changed to align with the RTRW spatial plan. More clearly, the stages of analyzing the alignment of land-use with the RTRW spatial plan are presented in Figure 4.

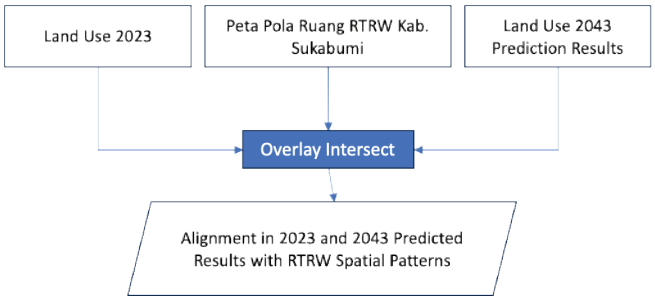


Figure 4. Flowchart of land-use compatibility analysis with RTRW spatial pattern.

Preparing Guidelines for the Improvement of the RTRW Spatial Pattern

The direction for the improvement of the RTRW spatial pattern is compiled spatially and descriptively based on several results from the analyses that have been conducted. The improvement of the spatial pattern is compiled based on the table of directions for the improvement of the spatial pattern in accordance with the analysis results of Land-use Compatibility and Land-use in 2043 predicted results with the Regional Spatial Plan (RTRW) of Sukabumi Regency. Several considerations in the preparation of spatial pattern improvement directives at locations where deviations occur are:

1. Land-use/land cover that has been in accordance with the RTRW spatial pattern is advised to remain consistent with the spatial pattern.
2. Transitional landuse/land cover is directed to ensure its spatial utilization remains in accordance with the spatial pattern; and
3. Land-use/land cover that is inconsistent with the spatial pattern is recommended to be refined during the RTRW revision and adjusted to the existing land-use.

RESULTS AND DISCUSSION

Land-use Changes from 2015-2019 and 2019-2023

Changes in land-use/land cover in 2015 and 2019, land-use is still dominated by Forests despite experiencing a decline. Unbuilt land-use/land cover was converted into Settlements and Activity Areas covering 429.72 Ha. The most extensive land-use/land cover converted into built-up areas were Forests covering 291.16 Ha, followed by Agricultural Fields covering 87.64 Ha. The land-use/land cover that remained unchanged covered 23,912.16 Ha (75%) and the changed areas covered 8,006.54 Ha (25%). The map of land-use/land cover changes from 2015 to 2019 is presented in Figure 5.

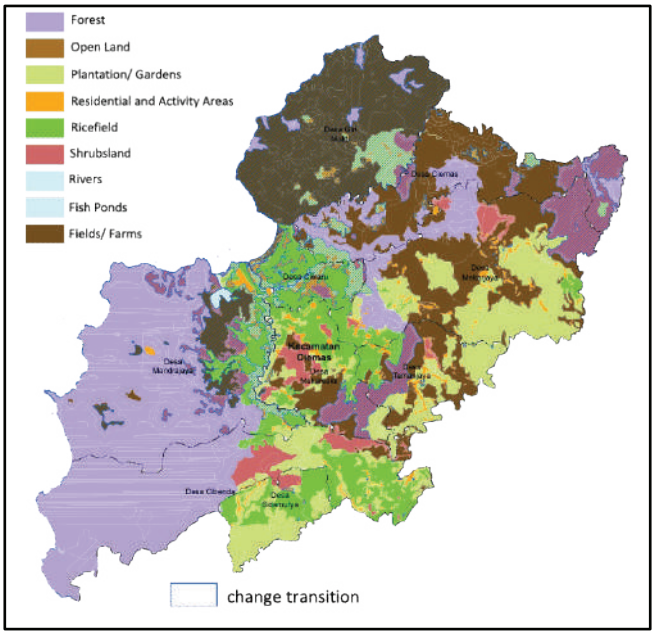


Figure 5. Changes in land-use from 2015-2019.

During this period, Ciemas District and Ciracap District were designated as National Geoparks in 2015, then proposed as part of the Global Geopark Network (GGN) until they were finally recognized by UNESCO in 2018. Since 2015 until 2019, the geopark area underwent changes in infrastructure to meet the eligibility as a Global Geopark. The reduction in the area of rainforest due to land-use changes. Yuda et al. (2024) state that the status of an international geopark brings significant changes, especially in the sectors of infrastructure, local economy, and education. Previously, this area was still a natural forest with limited access and unmanaged tourist attractions. UNESCO's recognition brings consequences, including road improvements and more serious management of tourist destinations according to periodic evaluation standards.

In addition, there is a trend of population growth increasing from 48,958 people in 2015 to 51,387 people in 2019 (BPS, 2024). In line with the research by Zalmita et al. (2020), which states that there will be an increase in the rate of land-use change in an area as a result of population growth.

Changes in land-use/land cover from 2019 to 2023 show that land-use is still dominated by Forests, although there has been a decrease in area compared to the previous period. Unbuilt land-use/land cover (Open Land, Plantations/Gardens, Rice Fields, Shrubs, and Fields) has been converted into Settlements and Activity Areas covering 47.69 Ha. The largest area of land-use/land cover converted into built-up land is Plantations/Gardens covering 19.86 Ha. The area of

land-use/land cover that remained unchanged is 30,893.63 Ha (97%) and the area that changed is 1,025.52 Ha (3%). The map of land-use/land cover changes from 2019 to 2023 is presented in Figure 6.

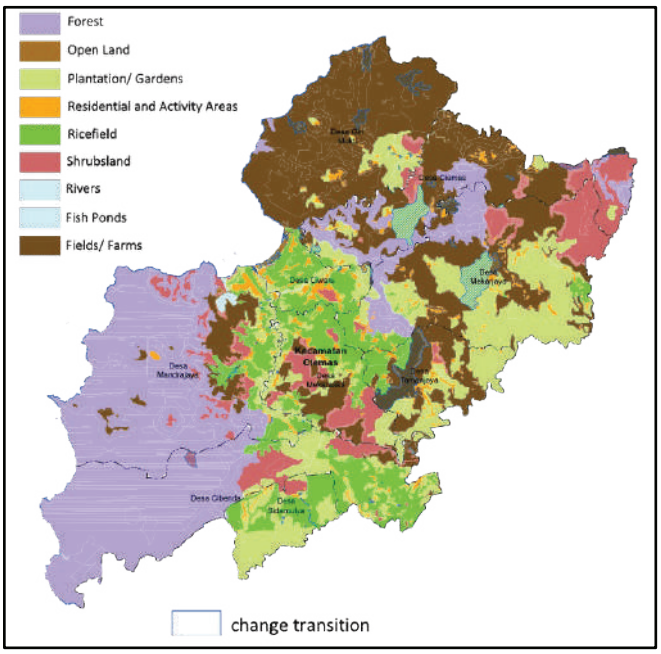


Figure 6. Changes in land-use from 2019-2023.

Land-use changes from 2019-2023 are influenced by government policies in developing the Geopark Area as outlined in the Master Plan for the UNESCO Global Geopark Ciletuh-Palabuhanratu for 2020-2030 (Sukabumi Regent Regulation Number 25 of 2021) (Pemda Kab. Sukabumi, 2021). The development of the geopark also encourages the conversion of undeveloped land into developed land as regional infrastructure and the establishment of tourist attractions supported by amenities that require space progress. In addition, it is known that there has been an increase in the area of plantation land as a result of food security policies involving the Ministry of Agriculture and the Indonesian Army. According to BPS (2024), there has been a 35% growth in the area of plantation land from 2019 to 2023.

Overall, land-use changes in the 2019-2023 period were not as drastic as in the 2015-2019 period, where the changes reached 25%, while in the 2019-2023 period, the changes were around 3%. This situation was also influenced by the Covid-19 pandemic, which affected economic growth, with sectors such as transportation and tourism being the most impacted by the pandemic (BPS, 2020).

Prediction of Land-use in 2043

The prediction of land-use in 2043 using Cellular Automata (CA) modeling, which is widely adopted and applied in the field of earth sciences, is one of the studies on land-use change (Yudarwati et al., 2017). Before making the land-use prediction for 2043, an accuracy test was conducted with a high Kappa value of 0.83, indicating almost perfect agreement (0.81-1.00). The results of the accuracy test are presented in Figure 7.

In line with the research by Permana et al. (2021), the kappa value proves that the model can be used to predict future land-use. The land-use prediction results for the year 2043 show massive changes in land-use/land cover, with a sequential reduction in Forests, Plantations/Gardens, Rice Fields, Rivers, Open Land, and Ponds. The changes in land-use/land cover that increased in area, in order from the largest, are Fields, Shrubs, Settlements, and Activity Areas. The land-use/land cover that remained unchanged covers an area of 23,930 Ha (75%), while the changed area is 7,989 Ha (25%).

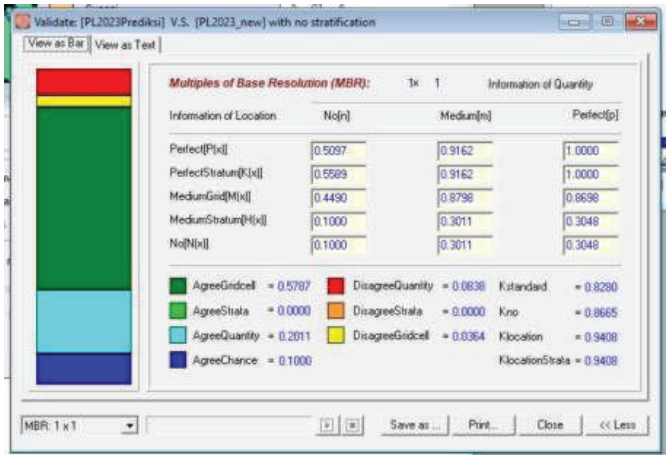


Figure 7. Data accuracy level.

The Ciletuh-Palabuhanratu Geopark area is planned as a conservation area with the main goal of protecting biodiversity, ecosystems, and natural resources. In addition, this area also plays a role in maintaining environmental balance, preventing disasters, and supporting research and ecotourism activities. To support that vision, land-use must be controlled to align with the spatial planning. Prediction results show the conversion of jungle land into built-up areas by 2043. There is a need for policy support in the form of spatial utilization control directives so that utilization follows the boundaries of the designated protected areas. One of the control instruments is to prepare and establish a Detailed Spatial Plan (RDTR).

Land-use Alignment in 2023 and 2043 Predicted Results with RTRW Spatial Patterns

The alignment of land-use in 2023 with the Spatial Pattern of the RTRW shows a consitent of 73%, Transition 16%, and inconsistent 12%. The alignment of land-use with the spatial pattern reaching more than 70% indicates that most land-use in the area is in accordance with the established regional spatial

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planning. Land-use that is in harmony with the spatial pattern is recommended to be continued in the future (Sitorus et al., 2019).

The land-use in order of the highest level of alignment are Plantation/Garden 93%, Fishpond 92%, River 90%, Forest 86%, Rice Field 85%, Open Land 73%, Fields/Farms 63%, Settlement and Activity Areas 48%. This land-use means that development and activities in Ciemas District are proceeding according to the goals and directions set in the Sukabumi Regency Spatial Planning (RTRW) for the years 2023-2043 (Pemda Kab. Sukabumi, 2023). In addition, the high level of alignment is due to the process of preparing the Sukabumi Regency RTRW, which was carried out using land-use from 2019 as the base map.

The use of landuse/land cover in transition, in order from the largest, are Shrubland 98%, Open Land 26%, Fields/Farms 17%, Rice Fields 11%, and Plantations/Gardens 7%. Meanwhile, the land-use that is inconsitent, in order, are Residential and Activity Areas 52%, Fields/Farms 19%, Forest 14%, Rivers 10%, Ponds 8%, Rice Fields 4%, Shrubland 2%, Open Land 2%, and Plantations/Gardens 0.1%. The Consistent of Land-use/Land Cover in 2023 with the RTRW Spatial Pattern is presented in Table 3.

Table 3. Alignment of land-use/land cover in 2023 with RTRW spatial pattern.

Land-use / Land Cover in 2023	RTRW Spatial Pattern					
	Consistent		Transition		Inconsistent	
	Hectare	%	Hectare	%	Hectare	%
Forest	8.171	86%			1.328	14%
Open land	64	73%	23	26%	1	2%
Plantation / gardens	5.341	93%	396	7%	7	0%
Residential and activity areas	523	48%	-	-	558	52%
Ricefield	2.911	85%	371	11%	123	4%
Shrubland	-	-	2.818	98%	67	2%
Rivers	102	90%	-	-	11	10%
Fish ponds	49	92%	-	-	4	8%
Fields / farms	5.866	65%	1.501	17%	1.688	19%
Total Area (Ha)	**23.026**	**72%**	**5.109**	**16%**	**3.784**	**12%**

The alignment of land-use/land cover in 2043 predicted with the RTRW spatial pattern, shows that consistent land-use is 50%, transition 35%, and inconsistent 16%. The land-use with the highest alignment levels are Forest 99%, Ponds 91%, Rice Fields 88%, Plantations/Gardens 84%, Rivers 70%, Open Land 48%, Fields/Farms 40%, Shrubs 28%, Settlements and Activity Areas 21%. The alignment level of land-use in 2043 is lower than the alignment of existing land-use, which reaches 72%.

The transition of land-use/land cover in order from the largest is Shrubland 68%, Fields/Farms 46%, Open Land 39%, and Rice Fields 11%. Meanwhile, the inconsistency in land-use in order is Residential and Activity Areas 79%, Rivers 30%, Fields/Farms 14%, Open Land 13%, Plantations/Gardens 12%, Ponds 9%, Shrubland 4%, Rice Fields 1%, and Forest 1%. More clearly, the alignment of land-use/land cover in 2043 predicted with the RTRW Spatial Pattern is presented in Table 4.

Table 4. Alignment of land-use/land cover in 2043 predicted results with RTRW spatial pattern.

Land-use / Land Cover in 2043	RTRW Spatial Pattern					
	Consistent		Transition		Inconsistent	
	Hectare	%	Hectare	%	Hectare	%
Forest	857	99%	-	-	10	1%
Open land	34	48%	28	39%	9	13%
Plantation / gardens	4.259	84%	221	4%	613	12%
Residential and activity areas	550	21%	-	-	2.123	79%
Ricefield	2.729	88%	329	11%	40	1%
Shrubland	1.600	28	3.818	68%	220	4%
Rivers	48	70%	-	-	21	30%
Fish ponds	49	91%	-	-	5	9%
Fields / farms	5.756	40%	6.627	46%	1.974	14%
Total Area (Ha)	**15.882**	**50%**	**11.022**	**34%**	**5.015**	**16%**

The inconsistency in the use of existing land with spatial patterns, such as residential areas and activity sites located in zones not designated for such purposes, like in agricultural areas covering 535.69 Ha or 1.68% of the total area of Ciemas District. Factors that can influence deviations or inconsistencies in the realization of spatial planning include market development pressures, unclear control mechanisms, and weak law enforcement (Rosdiana, 2018).

Guidelines for the Improvement of Spatial Patterns of RTRW

The direction for spatial pattern improvement is arranged spatially and descriptively based on several results from the alignment analysis. The improvement direction is aimed specially at transitional land-use/land cover and is inconsistent with the RTRW spatial pattern. The direction for spatial pattern improvement based on the category of alignment are as follows:

1. Land-use that aligns with the RTRW spatial pattern is recommended to remain in accordance with its intended purpose. In line with the research by Sitorus et al. (2019), land-use that aligns with the spatial pattern is recommended to continue in the future.
2. The use of transitional land with spatial patterns is recommended as follows:
   - The existing land-use consists of dense forests, which in the spatial pattern includes water bodies, horticultural areas, plantation areas, rural settlement areas, and food crop areas. It is recommended that the existing land-use be encouraged to align with the spatial pattern.
   - The use of existing land in the form of Open Land, which in the spatial pattern includes Water Bodies, Nature Reserves, Production Forests, Plantation Areas, Rural Settlement Areas, and Food Crop Areas. It is recommended that the use of existing land be encouraged to align with the spatial pattern.
   - The existing land-use in the form of plantations/gardens, which in the spatial pattern includes water bodies, wildlife reserves, protected

forests, production forests, tourism areas, aquaculture areas, and rural settlement areas. It is recommended that the existing land-use be encouraged to align with the spatial pattern.

- The existing land-use in the form of rice fields, which in the spatial pattern includes Wildlife Reserves, Production Forests, Tourism Areas, Aquaculture Areas, Horticulture Areas, Plantation Areas, and Rural Settlement Areas. It is recommended that the existing land-use be encouraged to align with the spatial pattern.
- The existing land-use in the form of Shrubland, which in the spatial pattern includes Water Bodies, Nature Reserves, Wildlife Sanctuaries, Production Forests, Tourism Areas, Horticultural Areas, Plantation Areas, Rural Settlement Areas, and Food Crop Areas. It is recommended that the existing land-use be encouraged to align with the spatial pattern.
- The existing land-use in the form of fields/farms, which in the spatial plan includes Water Bodies, Nature Reserves, Wildlife Sanctuaries, Production Forests, Aquaculture Areas, Plantation Areas, and Rural Settlement Areas. It is recommended that the existing land-use be encouraged to align with the spatial pattern.

3. Land-use that is inconsitent with spatial patterns is recommended as follows:
   - The existing land-use in the form of Settlements and Activity Areas, which in the spatial pattern includes Water Bodies, Wildlife Reserves, Production Forests, Aquaculture Areas, Horticultural Areas, Plantation Areas, Local Protection Areas, and Food Crop Areas, it is directed to be harmonized with the existing land-use.
   - The use of existing land in the form of rivers within the spatial pattern of Tourism Areas, Horticultural Areas, Rural Settlement Areas, and Food Crop Areas, it is directed to be harmonized with the use of existing land.
   - The existing land-use in the form of ponds, which in the spatial pattern consists of Tourism Areas, Horticultural Areas, Rural Settlement Areas, and Food Crop Areas, it is directed to be harmonized with the existing land-use.

CONCLUSION

During the 2015–2019 period, the land-use/land-cover (LULC) categories experiencing the largest decreases in area, in descending order, were forests, rice fields, and open land. In contrast, fields/croplands, shrubs, plantations/gardens, and settlements and activity areas experienced the largest increases in area, respectively. During the 2019–2023 period, the largest decreases occurred in shrubs, forests, and rice fields, whereas the largest increases were observed in plantations/gardens, settlements and activity areas, open land, fields/croplands, and rivers, in descending order.

The 2043 projections indicate that forests, plantations/gardens, rice fields, rivers, open land, and ponds will experience the largest decreases in area, in descending order. Conversely, fields/croplands, shrubs, and settlements and activity areas are projected to experience the largest increases.

The assessment of existing LULC conformity with the spatial pattern designated in the Sukabumi Regency Regional Spatial Plan (Rencana Tata Ruang Wilayah, RTRW) indicates that 72% of the area is consistent with the plan, 16% falls into a transitional category, and 12% is inconsistent with the designated spatial pattern. Fields and agricultural land constitute the dominant category among areas that are inconsistent with the plan. For the projected LULC in 2043, the proportions are 50% consistent, 35% transitional, and 16% inconsistent with the RTRW spatial pattern.

Recommendations for refining the spatial pattern provisions of the Sukabumi Regency RTRW in Ciemas District should be based on the conformity status and characteristics of existing and projected LULC. Areas whose current use is consistent with the designated spatial pattern should generally retain their existing functions. Transitional areas should be managed and directed toward land uses that conform to the RTRW. Existing permanent land uses that are inconsistent with the spatial plan, particularly settlements and activity areas associated with tourism and industry, should be considered for inclusion in the refinement or revision of the Sukabumi Regency RTRW, subject to further spatial planning assessment and applicable regulations.

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