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Application of land cover Maps for comparison of alignment of land capability between predictions of land use in 2035 based on trends and spatial planning policies (RTRW)

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ABSTRACT

The Puncak area is administratively located in Bogor Regency, West Java Province. Its function has been designated as an area to support the ecological sustainability of the Megacity Jakarta area, which is the capital of the Republic of Indonesia. So that land use based on its land capability is very important to pay attention to in managing this area. The main objective of this research is to analyze the comparison between the land cover alignment in 2035 from the results of the trend scenario with the land alignment in 2035 from the RTRW policy scenario based on land capability. This research method consists of three stages, namely the first stage interpreting satellite imagery using a Geographic Information System (GIS), the second stage by carrying out land cover projections in 2035 based on trend scenarios and RTRW policy scenarios using Artificial Neural Network (ANN), the third stage by doing Comparison of the alignment of land cover in 2035 from scenario results based on land capability. The results of this study indicate that there are differences in land use harmony, namely based on the results of the trend scenario cover, there are 1126 hectares in accordance with the land capacity and 6942 hectares, while the land use and from the projections of land cover policies based on regional spatial planning (RTRW) Bogor Regency is in accordance with the land capacity of 12589 hectares, while those that are not suitable are 5779 hectares.

Key words : *Land cover map, Land capability, Prediction of land alignment.*

Pendahuluan

Indonesia has realized the importance of sustainable development by implementing spatial planning policies that are based on an analysis that prioritizes sustainability and environmental protection through Law No. 26 of 2007 on spatial planning and spatial planning (RTRW). Sustainable development is closely related to the carrying capacity of the land, which is the ability of an area to maintain various activities to utilize available resources so that it can be dynamic depending on the activities in it (Ratnawati and Indrajaya, 2012). The land has a limited carrying capacity so that its use needs to be adjusted according to its capacity so that damage does not occur that can endanger the ecosystem in it

(Sadesmesli, 2017). The dominant factor affecting land cover change is humans, this is because human activities cannot be separated from land (Yusuf *et al*. 2018).

To optimize the carrying capacity of an area, of course, it is necessary to understand the physical components of spatial (Zhang, 2017). From the spatial study of land cover, it describes the socio-economic activities of the community as seen in the physical form of land use in an area (Rustiadi, 2016). Land use activity has an impact on the carrying capacity of the land which is spatially analyzed based on the driving mechanism of the land change (Liu *et al.* 2018). To analyze the carrying capacity of the land, the concept of carrying capacity has been widely used in various disciplines in connection with environmental sustainability. This concept can be used as a benchmark in analyzing the maximum limit of a land's ability to determine the carrying capacity of an area (Zhou *et al.*, 2019a).

As in the Jabodetabek area, the process of land conversion has occurred so rapidly in the last few decades due to the influence of the urban development of DKI Jakarta (Pravitasari, 2015; Rustiadi and Retno, 1999). According to Kurnianti *et al*. (2016), Changes in land use in the Jabodetabek area are very dynamic, the increasing need for residential land has converted a lot of agricultural lands. Another phenomenon that occurs in the Jabodetabek area is the uncontrolled expansion of the built-up land area triggered by the road network (Tarigan *et al.*, 2010 and Fajarini *et al.*, 2015). One of the areas in the Jabodetabek area that needs to be maintained based on its land support capacity is the Puncak area. This area is located in the administrative area of Bogor Regency and is the upstream area of several river basins (Ciliwung) which empties into DKI Jakarta, which is the capital of the Republic of Indonesia, which is determined by the government to become a national strategic area with a function as a buffer zone to maintain ecological sustainability in areas is around (PERPRES 54 2008).

Currently, land conditions in the Puncak area are very susceptible to land-use conversion as a result of increased economic activity and population growth which encourages an increase in the need for developed land. The land uses that have changed many functions in the Puncak area are agricultural and plantation lands and forest areas (Dewinta, 2018). From these conditions, it is necessary to analyze natural resources in evaluating spatial planning based on the study of the carrying capacity of the land (Rustiadi *et al*., 2009).

One method of analysis in planning to manage and develop potential land resources in the area in the Puncak area is by analyzing the carrying capacity (Rustiadi *et al.*, 2009). The carrying capacity of the land can be analyzed by classifying the land capability by weighting the land capability class which is carried out systematically based on the nature of the land for sustainable land use (Arsyad, 1989). Based on some of the things mentioned above, the objectives of the study are (1) Identify land cover changes in 2019-2035 based on land-use trends and spatial planning (RTRW) policies in the Puncak area of Bogor Regency (2) Comparing land alignment based on the land capability from the results of land cover projections in 2035 and based on land-use trends and from the results of projected land cover policies based on the Bogor Regency regional spatial planning (RTRW) policy.

Materials and Methods

Study Location

The location of this research is in the Puncak area of Bogor Regency, West Java Province. The research focus is in Ciawi District, Megamendung District, Cisarua District. The Puncak area is geographically located between 106 ° 49'49.63 "E - 107 ° 0'24.78" east longitude and 6 ° 37'29.96 "- 6 ° 46'9.04" south latitude. The total area of the study is ± 18,371.14 hectares. This location is the Jabodetabek National Strategic Area (KSN) and has been designated with a function as land and water conservation as well as a protected area.

Study Method

The study method of this study begins with the preparation of land cover maps for 2005 and 2019 with a scale of 1: 50,000 which is obtained from the interpretation of Landsat imagery in 2005 and 2019 with remote sensing techniques. Before the interpretation is carried out, the image is cut according to the study area, namely the Puncak area of Bogor Regency. Then the land cover classification is carried out with the classes observed are forest, garden/plantation, built-up land, paddy field, moor/field, shrubs, open areas, and water bodies. The land cover classification is then verified with Google Earth on a scale of 1: 25,000 and land cover classes

that are not identified are checked by conducting a field survey using GPS.

Furthermore, projections of land cover in 2035 are carried out using the *Land Change Modeler (LCM)* application model with a transition model approach with the driving factors for land conversion, namely roads, rivers, tourist areas, activity centers, service centers, slope, topography, and disaster-prone. carried out running with a *Multi-layer perception(MLP)* model and *Artificial Neural Network* for *(ANN)* then validated with a crosstab map of actual land projections in 2019 using the Kappa method.

Comparison of the alignment of land cover to the carrying capacity of land in 2035 based on land-use trends and RTRW policies are analyzed based on land capability by using the land capability classification method based on the physical conditions of the land. In this land analysis method, the land capability classification is determined based on the subclass of the physical analysis method by considering slope conditions, morphological conditions, erosion conditions, waterlogging conditions, waste conditions, water availability, soil depth, soil texture, gravel, and rock conditions, affordability. and disaster-prone.

From the incorporation of the physical conditions of the land, then the classification becomes eight 8 (eight) classes of land capability based on existing limiting factors ranging from class I (one) to have a high management ability to class VIII (eight) has a large inhibiting factor so that the management capability is high. very low. The results of the land capability are then processed in the spatial form which produces a land capability map. Furthermore, comparisons of land cover alignment based on the carrying capacity of the land in 2035 are carried out by overlaying the land capability map with the map of the projection of land cover in 2035 based on the scenario of land cover trend and land cover projections based on the scenario of the Bogor Regency regional spatial planning policy (RTRW).

Results

From the results of image interpretation in 2005 and 2019, it can be seen that changes in land cover indicate that the availability of land has an attraction for land demand causing land conversion in the Puncak area.This is in line with the research resultsof Dani (2016) which states that the peak area is still considered capable of serving the needs of the surrounding community compared to other areas, this causes a high attractiveness in this area. The land cover change between 2005-2019 is presented in Table 1.

From Table 1 above, it can be seen that land change is mostly influenced by the high land demand for developed land and plantations. Meanwhile, those who have changed their function are forests, fields, and rice fields. Meanwhile, the body of water did not change significantly.

Table 1. Changes in Land Cover 2005-2019

Land Cover	Area of Change (Hectares)		Difference
	2005	2019	
Forest	7,646	5,958	-1,688
Garden/Plantation	3,685	5,155	1,470
Field/Moore	2,306	1,785	-521
Build of Land	1,299	3,029	1,730
Open Field	3	32	29
Rice Field	3,013	2,107	-906
Shrubs	378	263	-115
Body of Water	42	42	-0
Total	18371	18371	

Projections of land cover in 2035 based on scenarios between land cover trends and regional spatial planning (RTRW) policy scenarios are carried out to see the possibility of land changes that occur in the future which are influenced by driving factors of land change such as distance from roads, activity centers, rivers and land physical conditions.

Table 2 shows the results of the comparison of land cover in 2035 based on land-use scenarios in the Puncak area. The area of built land is increasing while the forest is decreasing.Comparison of land changes in 2035 based on land use trend scenarios and RTRW policy scenarios can be seen in Table 2.

The area of built land is increasing while the forest is decreasing. In general, the increase in the area of flying land has the potential to convert other land functions. This is in line with research (Sampurno and Thoriq, 2016). The area of built land is increasing while the forest is decreasing. In general, the increase in the area of flying land has the potential to convert other land functions. This is in line with research. Comparison of land cover based on predicted land cover in 2035 based on land cover trends can be seen in Table 3.

From Table 3 above, it can be seen that the comparison of the land cover area in 2035 based on the results of the land cover trend scenario can be seen in Figure 1.

Table 2. Perbandingan perubahan lahan tahun 2035 berdasarkan skenario penggunaan lahan

Land Cover	2019	Comparison of Land Cover 2035	
		Trend	RTRW
Forest	5,958	-1,416	-1,413
Garden/Plantation	5,155	390	388
Field/Moore	1,785	-171	-171
Build of Land	3,029	1,939	1,938
Open Field	32	0	0
Rice Field	2,107	-803	-804
Shrubs	263	62	61
Body of Water	42	0	0
Total	18371		

From Figure 1 above, it can be seen the comparison of land cover area based on the trend of land cover in 2035. A map of prediction of land cover in 2035 based on the trend of land cover. Furthermore,

Table 3. Comparison of land changes in 2035 based on land-use scenarios

Land Cover	Projection of Land Cover in 2035	
	Trend	RTRW
Forest	4,542	4,545
Garden/Plantation	5,544	5,543
Field/Moore	1,614	1,614
Build of Land	4,968	4,967
Open Field	32	32
Rice Field	1,304	1,303
Shrubs	324	324
Body of Water	42	42
Jumlah	18371	18371

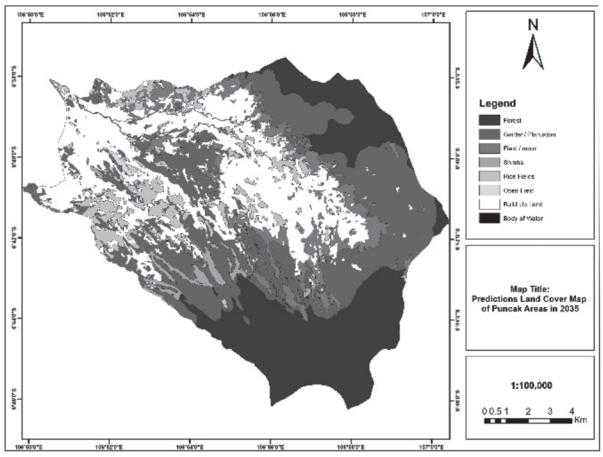

Fig. 1. Land cover in 2035 based on trend

the land cover prediction map of land cover based on the RTRW policy scenario can be seen in Figure 2.

Furthermore, from the results of the land capability analysis, which is then classified into land capability classes in the Puncak Area, there are seven land capability classes in this area, starting from

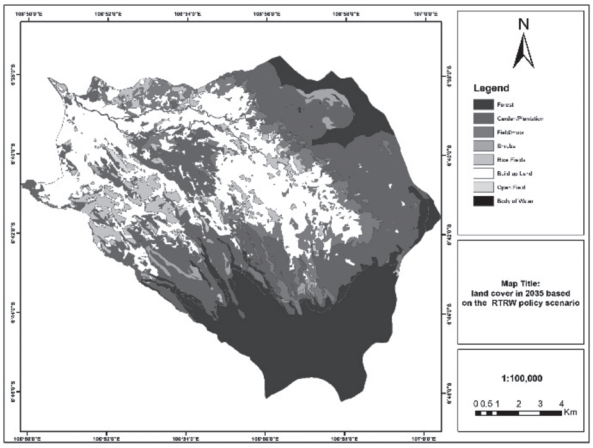

Fig. 2. Land cover in 2035 based on the RTRW policy of Bogor Regency

class II (two) to Class VIII (eight) and there are no land capability classes in the criteria. class I (one) this is because the Puncak Area has physical characteristics of the land which vary from the level of disaster-prone to which is a factor limiting the ability of land in terms of management. Classification of land capability based on the coverage area can be seen in Table 4.

From Table 4 above, it can be seen that the classification of coverage areas based on land capability class shows that class VIII (eight) has the largest percentage area, namely 35.76 percent and class V has the smallest percentage area, namely 5.45 percent. Meanwhile, classes II (two), III (three), IV (four), VI (six), and VII (seven) have a percentage that is 7.41

Table 4. Classification of coverage area based on land capability class

Class	Area(Hectare)	Percent(%)
II	1360	7.41
III	1503	8.19
IV	1975	10.76
V	1000	5.45
VI	2898	15.78
VII	3061	16.67
VIII	6568	35.76
Total	18371	100

percent to 16.67 percent. From this class, the land capability in this area varies. The distribution of land capability based on land capability class can be seen in Figure 3.

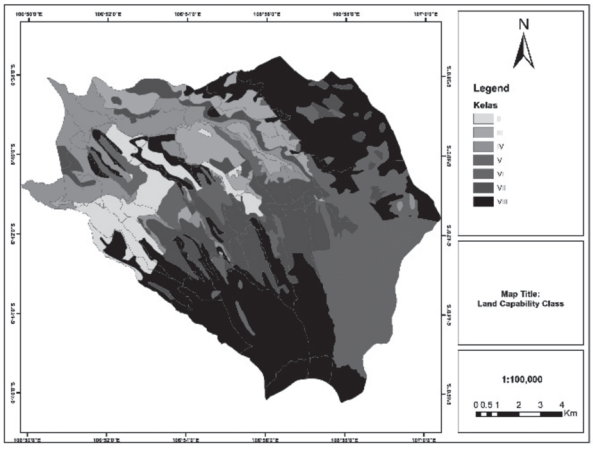

Fig. 3. Distribution of land capability based on land capability class

From the prediction results of land cover based on the land cover scenario in 2035 based on the land cover trend scenario and the regional spatial planning (RTRW) policy scenario, an overlay is carried out with a land capability map to see the comparison of land capability alignment based on land cover in 2035. based on land capability in Table 5.

In Table 5, it can be seen that there is a comparison between the alignment of land cover in 2035 based on the land cover scenario based on trends, namely those that are not in line with land cover capacity, namely 6942 and in line with 11428 hectares, while the land cover in 2035, while based on the RTRW scenario that is not in line with land capability, namely 5779 hectares while those in tune 12589.A comparison diagram of the harmony of land use between land cover in 2035 based on the trend of land cover and the RTRW Policy of Bogor Regency can be seen in Figure 4

Table 5. Comparison of land capability based on projected land cover in 2035 from the scenario of land cover trend and RTRW policy

Class	Trend (Hectare)		RTRW (Hectare)	
I	A	NA	A	NA
II	1360	-	1360	-
III	1504	-	1504	-
IV	1975	-	1975	-
V	1000	-	1000	-
VI	2475	422	2534	364
VII	1017	2043	1039	2022
VIII	2092	4476	3176	3392
Total	11426	6942	12589	5779

Keterangan: A: Alignment NA: Not Alignment

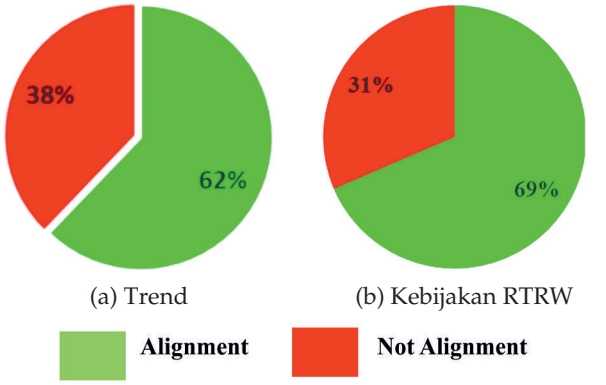

Fig. 4. Pie chart comparison of land capability compatibility in 2035

From Figure 4, it can be seen that the comparison of capacity with land cover shows that there is a difference between the alignment of land cover in 2035 based on the land cover scenario based on trends, namely those that are not in line with land cover capability, namely 38% while the RTRW scenario is not in line with land capability, namely 31% while 69% aligned. From the diagram above, it can be seen that the application of spatial planning policies in the Puncak area of Bogor Regency can apply land use that is not in line with land cover.

Map Comparison of land use harmony between land cover in 2035 based on trends and the Spatial Planning Policy (RTRW) of Bogor Regency can be seen in Figure 5.

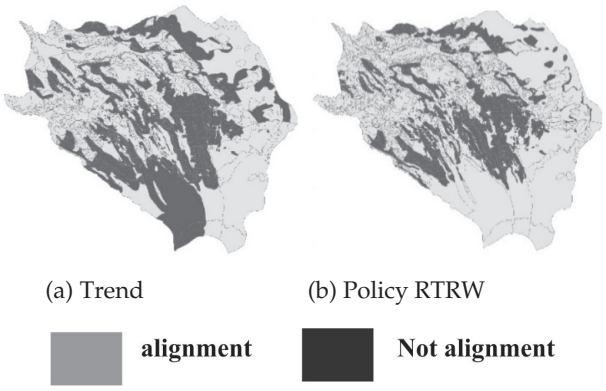

Fig. 5. Land alignment based on the RTRW scenario of Bogor Regency

Discussion

The availability of satellite image data is a form of advances in information technology at this time which has enormous benefits to enrich science. In the last two decades, remote sensing imagery combined with field measurements has been used intensively for cost-effective mapping of land cover or vegetation (Nawar, 2015). Satellite image data processing with the Geographic Information System (GIS) approach has the advantage of providing information on the spatial diversity on the earth's surface quickly, broadly, precisely, and easily and at a relatively low cost and the result is a map as information that can be used in general. by humans (Sampurno and Thoriq, 2016)

Furthermore, land-use change can be projected by *land change modeler* (LCM) analysis to predict changes in land cover over several years using the *artificial neuron network* (ANN) approach. This analysis considers the driving factors for land change. An *artificial neuron network* (ANN) is a method for solving complex problems in the same way as the human brain (Haykin, 2010).

To obtain land cover prediction results that accurately approximates the actual land cover conditions in an area, it is necessary to be careful in analyzing and processing data such as driving factors for land change(Pravitasari *et al.,* 2018). Driving factors that influence changes in land cover in an area, namely roads and activity centers, so that this element is important to consider and other elements that are considered to influence future land cover changes in an area. area space (RTRW)(Rustiadi, 2016).

Land in an area that has changed can be seen that there is a physical appearance of the land cover so that many research on land changes are used as a method to determine land developments that occur in an area (Maksum *et al*. 2016). Furthermore according to (Cahyono *et al.,* 2019). Land cover provides an appearance between natural processes and social processes in an area so that it can provide important information to analyze human activities and global change.

Analysis of the carrying capacity of the land is an analysis that examines the relationship between regional resources and the environment as well as human activities as an element that plays an important role in sustainable development by analyzing the limiting factors in an area (Chapman and Byron 2018). Furthermore, the carrying capacity of the land is determined by the need *(demand)* and availability *(supply)* from an environmental perspective, the carrying capacity includes two components, namely supportive capacity and assimilative capacity (Rustiadi *et al.,* 2009).

To optimize the carrying capacity of an area, we must understand the spatial structure and physical components of the land by applying a method approach from statistical and spatial analysis (Zhang *et al*. 2018). The concept of carrying capacity has been widely used in various disciplines about environmental sustainability. This concept can be used as a benchmark in analyzing the maximum limit of a land's ability to determine the carrying capacity of an area (Zhou *et al*., 2019b).

The Puncak area of Bogor Regency is an area located in the Jabodetabek area from that location, the Puncak area is prone to land conversion so rapidly in the last few decades the land has developed at an unprecedented rate (Pravitasari *et al.,* 2015). So that it is necessary to analyze the carrying capacity of land as a solution to balance development to achieve sustainable development by exploring the effect of land use on the carrying capacity of land-based on spatial linkages and analyzing the impact of urbanization and agglomeration in an area with its driving mechanisms (Liu, 2018).

The results of land alignment analysis based on land capability can be taken into consideration for planners to determine land use in an area (Rustiadi *et al*., 2009). One analysis that can be carried out is to see the difference in land capacity based on the carrying capacity of an area, namely by comparing the alignment of land cover to land capacity, the data used is data from two land cover in the same year with the same difference can be found using the table or percentage using a comparison matrix (Pravitasari, 2015)

The use of GIS in conducting land use analysis is carried out by overlaying data with projections of land cover in 2035 based on trend scenarios and the application of the Bogor Regency Spatial Planning Policy (RTRW) with the results of land capability analysis. The analysis shows that there are differences in land capacity based on land cover. Therefore, this research offers a method to measure the application of land use that is suitable for the land capacity so that the carrying capacity is not exceeded in each area.

Conclusion

The use of GIS in processing satellite image data has an effective nature in identifying changes in land cover, which is then followed by the land cover projection method using an artificial neural network (ANN), it can be seen that there is a change in cover in 2019-2035 based on the trend, namely the forest area has decreased by -1,416 hectares, fields/moor -171hectares and paddy fields -803hectares while the increased land/plantation is 390 hectares, built land 1939 hectares, and shrubs 62 hectares while open land and water bodies do not experience changes while land use and spatial planning policy (RTRW) in The Puncak area of Bogor Regency is forest area decreasing -1,413 hectares, fields/moor -171 hectaresand paddy fields -804hectares while the land that has increased gardens/plantations is 390 hectares, built land 1939 hectares, and shrubs 61 hectares while open land and water bodies have not changed. From the comparison of land cover, it can be seen from the implementation of the policy RTRW will be able to reduce forest area reduction.

From the results of the comparative analysis of land alignment based on the land capability of the projection results of land cover in 2035 and based on the trend, namely those following the land capacity of 1126 hectares and those that are not suitable for 6942 hectares while land use and from the projection results of land cover policies are based on regional spatial planning policies (RTRW) of Bogor Regency is following the land capacity of 12589 while that is not suitable for 5779. From the results of this comparison, it can be concluded that the application of RTRW can reduce land use that is not following the capacity of the land so that its carrying capacity can be maintained.

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