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Modeling And Spatial Analysis Of Change Settlement And Fair Market Land Price Using Markov Chain Model In Banyumanik District

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Abstract

Banyumanik District is located on the outskirts of Semarang with very rapid development. Indicated with the many changes in land that occur, due to the construction of settlements and other physical buildings continues to increase. Changes in land use will also be followed by changes in market land prices. These changes will continue in line with the increasing number and activities of the population in carrying out economic, social and cultural life. Most of the studies was conducted to analyze changes in future land use are based on the use of a model. Land use modeling changes is a method or approach that can be used to understand the causes and effects of these dynamic changes. The Multi-Layer Perceptron (MLP) Neural Network and Markov Chain methods are used in this study to determine which locations or areas of land use are vacant land and agriculture has the potential to change into settlements and test the predictive ability that will be produced by the model. The driving factor for land use change as an input model consists of distance to the road, distance to the area experiencing changes in land use, slope, elevation and fair market land prices. This study aims to (1) predict settlement and its changes in Banyumanik District using High Resolution Satellite Image in 2011-2019, (2) build a model of settlement land use change with the Markov Chain methods and (3) projection of Banyumanik District land use in 2028.

Keywords: Settlements, Fair Market Land Prices, MLP Neural Network, Markov Chain

1. Introduction

Some developing countries face the problem of physical growth very quickly. One of them is Indonesia, which is experiencing serious problems in terms of population distribution that needs land to support their daily activities. Regional growth will require space as physical development of the land. Several Big Cities in Indonesia also experienced this problem. Rapid regional physical growth is a problem for some developing countries [1]. Banyumanik District is one of the districts in the suburbs of Semarang with very rapid development. The increase in settlements and other physical structures, in the last 9 years from 2011 to 2019 also increased. Information on the availability of vacant land and fair market land prices can be used to analyze models of settlement changes and the direction of their future distribution [2]. [3] Conducting research in Tembalang District, Semarang City resulted in a decrease in the availability of vacant land and an increase in settlement areas and followed by an increase in fair market land prices in the area The two terms basically have a functional relationship, namely the price of land is a function of land value, which means the rise and fall of land prices is determined or influenced by changes in land value in a particular area. The theory of land prices and one of the most popular is put forward by Von Thunen (1826), who assumes that land values are related to the relationship between distance, market and production. Changes in settlement and land prices can be analyzed using the model development [4]. The model developed is based on the dynamics of land use changes that occur in an area.

[5]. Research on modeling changes in settlements and land prices is conducted to determine the process and patterns of changes that occur and the variables that drive these changes. [6] Carried out modeling with models of changes in demographic and physical factors in residential land use in Costa Rica, including the reciprocal relationship of residential land use to the above factors. [7] uses modeling using the Multinomial Logistic Regression (MLR) method. The results of this modeling have been successfully built and can explain variations in land use changes at the study site. Land use predictions using the Markov Chain model and regression analysis for the next 20 years are also carried out in Beijing, China [8]. The modeling in this research is used to determine the location or any area of vacant land allocated or not and shurb and other land uses that have the potential to turn into settlements. Whereas GIS is used to construct the spatial aspects of the driving variables that affect change. Some of the variables that drive changes in land use are physical and economic variables. Physical variables are proximity to the road, proximity to the river, proximity to agricultural land and vacant land, height, and slope. While economic variables are population density, and market land prices. The purpose of the study is to model and analyze patterns of settlement changes and land prices in Banyumanik Regency that occurred during the 2011-2019 time interval.

2. Material and Method

2.1. Material

2.1.1. Studi Area

Banyumanik District, Semarang city, Central Java, Republic of Indonesia is the study area of this research. This area is located on the outskirts of the city and is at an average altitude of 300 meters above sea level. Banyumanik District located in the most southern region of the Central Government of Semarang city with hilly topography and settlement areas. The boundaries of the District Banyumanik Region are as follows: North is Candisari and Gajah Mungkur District, East is Tembalang District, South in Semarang District, West is Gunungpati District. Map Administration of the Banyumanik District show in Figure 2.

2.1.2. Research Data

The data in this study includes data spatial and non-spatial, there are;

1. Geometric corrected satellite image data for Spot 6 recording in 2013, 2016 and 2019
2. Map Administration of the Banyumanik District, Semarang City from Development Planning Agency
3. Data on Fair Market Land Prices in the period 2013, 2016 and 2019 were obtained from field surveys with provisions according to the National Land Agency
4. Space Pattern Plan map of the Banyumanik Distric part of RTRW Semarang City in year 2011-2031 from District Government
5. Physical variables are slope, land movement, type of soil from Development Planning Agency. Closeness to main road, closeness to river, closeness to vegetation and shurb obtained the digitizing on satellite imagery
6. Socio-economic variables are Population density obtained from statistical data and Fair Market Land Prices.

2.2. Method

2.2.1. Study Approach

A dynamic approach is used for the spatial model using spatial-based descriptive analysis and Markov Chain-Cellular Automata (CA). Spatial modeling of land use change is a method or approach that can be used to understand the causes and consequences of these dynamic changes. Whereas spatial-based descriptive analysis is used to determine the spatial distribution of settlement changes due to land changes in each unit.

2.2.2. Modeling Changes in Settlement

The definition of a spatial based model was put forward by [9], where the model is an abstraction from the real world system that has a significant detail problem with the problem being studied, and also has transparency, so that the mechanisms and key factors that influence change can be identified. Modeling changes in settlement one form of modeling that has attracted the attention of several researchers in the world. They study the existence of a causal relationship between the management of a land and land use changes that occur. Modeling settlement change has several uses, among others, to explore a variety of activities in which a change in settlement driven by socio-economic factors [10], predicting the economic and environmental impacts of these changes and evaluate the impact of government policies in determining land use and land management [11].

2.2.3. Modeling Changes in Fair Market Land Price

The spatial distribution of land prices can be obtained by spatial modeling of changes in land values in a particular area [12]. Land prices will be high in areas that have strategic locations with commercial uses such as settlements and trade and good accessibility. Land value data per square meter obtained from the results of the field survey is calculated by adding the adjustment percentage. Adjustments to transaction data types, status of rights with reference to ownership rights and time of transaction are calculated until December 31 of the current year. The area of the land price zone is determined by an area of 10x10 cm multiplied by a scale of 1:5,000 with a minimum of 3 (three) samples, while for zones above 10x10 cm, a sample of at least 5 (five). The selected sample is fair market land prices transaction type and land price offer. The land price of each sample in the zone is then calculated using the Average Land Prices (ALP).

2.2.4. Model of Markov Chain Land Use

Markov Chain technique is one of the methods that can be used to predict future land use changes. This model is related to a series of processes in which events due to an experiment or experiment only depend on events which immediately precedes it, and does not depend on the sequence of events before. If certain events in an experiment depend on several events that might occur, then the series of experiments is called a stochastic process. One of the software for Markov analysis is use the device Quantum GIS software (QGIS) by running the MOLUSCE module The data format used in the QGIS must be in the raster format. Keep in mind in determining the simulation of the coming year the prediction of the time should be in the range of the difference between the beginning and end of the year land use.

2.2.5. Validations Model Test

This modeling validation aims to determine the accuracy of the resulting land use prediction map. One of the common methods used for model validation is the Kappa statistical method. According to Altman, 1991 in [13] the Kappa value of 0.81-1.00 shows a very good agreement, 0.61-0.80 is good, 0.41-0.60 is moderate, 0, 21-0.40 is less than moderate, and a value <0.21 is said to be bad. The Kappa value can be expressed as a percent. Kappa calculations use equation 1–3 (NextGIS, 2013):

$$\text{Kappa} = (P(A) - P(E)) / (1 - P(E)) \quad (1)$$

$$\text{Kappa Loc} = (P(A) -- P(E))/(P\max -- P(E)) \quad (2)$$

$$\text{Kappa Histo} = (P\max -- P(E))/(1 -- P(E)) \quad (3)$$

3. Result and Discucssion

3.1. Changes in Settlements and Fair Market Land Prices

3.1.1. Land use validation and Fair Market land prices survey

Digitization of Spot 7 satellite imagery begins with preparations that include image cutting activities, geometry correction, visual classification and field checks. Next the image is corrected geometry with a ground control point (GPS). The results of the interpretation resulted in a 2011, 2015, 2019 land use map with 5 land use classes namely Settlement, Unoccupied Land allocated, Unallocated Empty Land, Vegetation and Shrubs. Field validation for land use surveys and fair market land prices is carried out simultaneously and can been show in Figure 2. The availability of vacant land that reduced is largely due to the transition of vacant land to settlements. One example of changing vacant land into housing use is shown in Figure 1.

Figure 1: The Result of validation changes in the use of vacant land into settlements in the Pedalangan Sub-district, the imagery of the year 2011 (a), the imagery of the year 2015 (b), 2019 imagery in period (c).

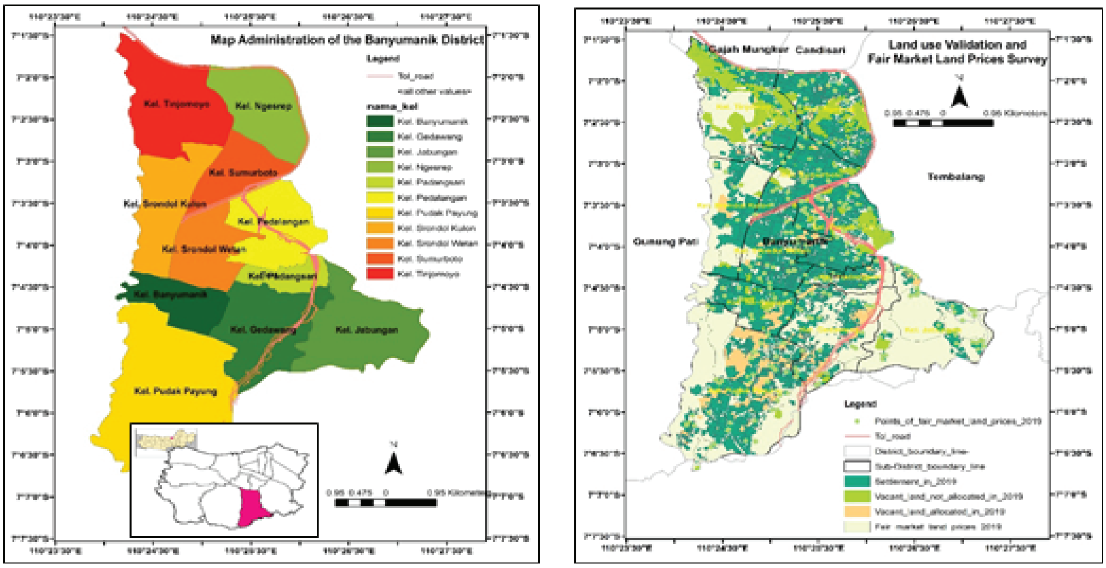

Figure 2: Map Administration of the Banyumanik District (a), and Overlay of settlement and a distribution of 300 sample points of market land prices and field check land used for field surveys (b).

3.1.2. Fair Market Land Price

The results of the field survey and processing of fair market price data for land obtained an average price indication or Average Land Prices (ALP). The ALP price for each zone of the fair market land price is obtained by calculating the average sample price of the market price for each zone. The maximum and minimum prices are determined from a sample of land prices for each zone. To analyze changes in land prices from 2011, 2015 and 2019 tables and graphs were made. These tables and graphs are shown in Table 1 and Figure 3.

Table 1: Fair Market Land Price In 2011, 2015 And 2019.

Fair Market Land Prices (Rp.)									
	2011			2015			2019		
Name of Village	Maximum	Minimum	ALP	Maximum	Minimum	ALP	Maximum	Minimum	ALP
Banyumanik	1.639.000	1.222.000	1.580.500	3.927.000	1.930.000	3.378.500	13.346.000	2.037.000	7.692.000
Gedawang	3.083.000	320.000	2.201.500	4.010.000	450.000	2.730.000	4.898.000	660.000	3.775.000
Jabungan	690.000	590.000	660.000	1.900.000	905.000	1.622.500	4.566.000	1.040.000	1.496.000
Ngesrep	3.206.000	319.000	1.962.500	4.250.000	850.000	3.250.000	7.394.000	2.625.000	5.012.000
Padangsari	3.285.000	1.276.000	2.530.500	4.870.000	2.015.000	3.842.500	6.145.000	2.976.000	5.720.000
Pedalangan	4.693.000	1.276.000	3.384.500	5.970.000	1.915.000	4.342.500	8.942.000	2.876.000	6.227.450
Pudak Payung	6.083.000	190.000	3.636.500	8.042.000	395.000	4.568.500	10.600.000	540.000	2.976.000
Srondol Kulon	5.223.000	190.000	3.306.500	6.860.000	355.000	4.307.509	14.274.000	1.472.000	5.876.000
Srondol Wetan	5.440.000	719.000	3.379.500	6.834.000	1.370.000	4.402.000	7.322.000	2.575.000	3.978.000
Sumurboto	6.068.000	2.718.000	4.893.000	9.850.000	4.105.000	7.377.500	19.095.000	4.290.000	7.991.000
Tinjomoyo	3.204.000	187.000	1.995.500	4.940.000	370.000	3.355.000	14.317.000	690.000	4.063.000
ALP = Average Land Prices									

From Table 1 above and Figure 3 it can be seen that all Sub-District in Banyumanik District experienced increases in land prices, both minimum and maximum. Each village experienced the highest increase in land prices starting from Sumurboto, Tinjomoyom, Srondol Kulon, and Banyumanik. The increase in almost every period is very high because it is a central region and business. In the past few years, land prices and land use changes in the 4 sub-district areas have shown an interesting phenomenon. The use of land previously in the form of open space, agriculture, and vacant land, turned into settlements and trade in services which were considered to have more commercial value strategic and competitive. While the villages experiencing the lowest price increase are Jabungan, which is a rural area and far from the city center. This is because land is an economic good whose availability continues to decrease every year.

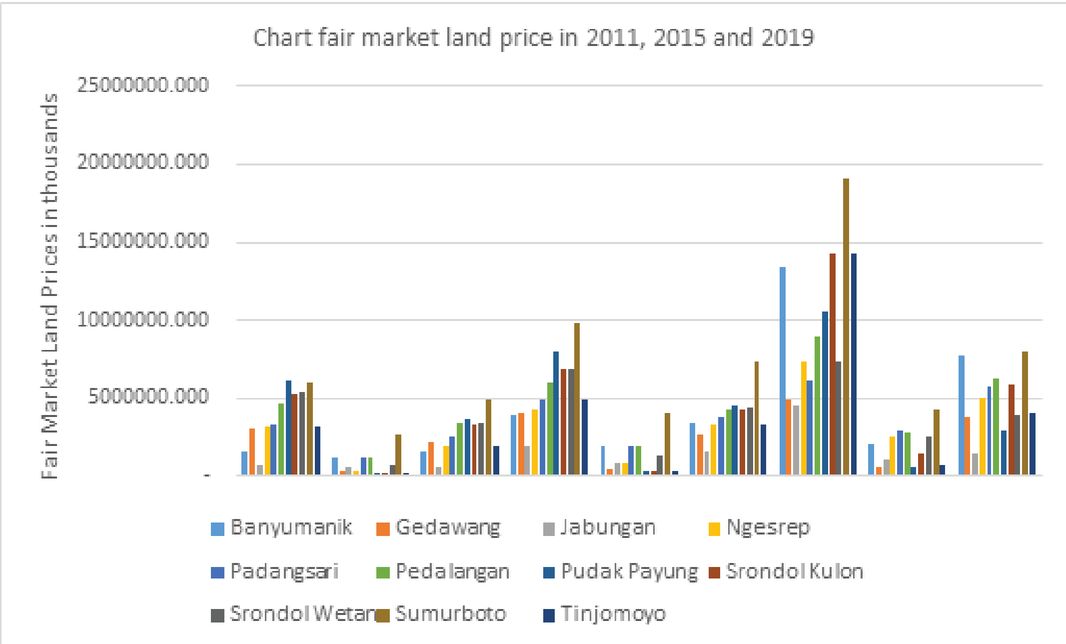

Figure 3: Chart fair market land price in 2011, 2015 and 2019.

3.2. Settlement Land Area in Predict 2028

3.2.1. Driving variables and value testing the value of Cramer's V

Some driving variables are changes in land use including closeness to the road, closeness to the river, closeness to settlements, population density, slopes, soil and climate. The closeness to roads, rivers and settlements is used as a factor of change in terms of the culture of the community, meaning that the closer the land is used to roads, rivers and settlements, the faster the land use changes will occur. Population density are included in socio factors that drive change, where these factors illustrate concretely the amount of demand for residential land. Slopes, land and climate also affect the change in land use. Variables are tested for the value of Cramer's V. Cramer's V measures the relationship between one variable with each land use with a value range of 0-1, where 0 indicates no association, while value 1 indicates a close relationship between these variables and land use. The Table 2 it can be seen that the variable has a Cramer's V value of more than 0.1 so that the variable can be entered into the model.

Table 2: The value of testing physical and social variables with the Cramer's V value test.

Cramer's Closeness to		Settlement	Vacant Land Allocated	Vacant Land Not Allocated	Vegetation	Shrub	Overall V
Agricultural Land	Cramer's V	0	0,1669	0,112	0,0974	0,2098	0,2258
	P Value	1	0	0	0	0	0
Main Road	Cramer's V	0	0,0953	0,1018	0,2533	0,1158	0,1581
	P Value	1	0	0	0	0	0
Population Density	Cramer's V	0	0,0601	0,049	0,0343	0,0826	0,044
	P Value	1	0	0	0	0	0
River	Cramer's V	0	0,0155	0,0241	0,0256	0,0126	0,0173
	P Value	1	0,1891	0,0007	0,0002	0,4972	0,0027
Type of Soil	Cramer's V	0	0,0601	0,049	0,0343	0,0826	0,044
	P Value	1	0	0	0	0	0
Vacant Land	Cramer's V	0	0,1286	0,1393	0,1042	0,1489	0,1072
	P Value	1	0	0	0	0	0

3.2.2. Model Validation Level

The results of the validation by the kappa method are presented below:

% of Correctness: 81.23475

Kappa (overal): 0.80550

Kappa (histo): 0,84842

Kappa (loc): 0,83052

Based on these results it shows that the results of the validation of this projection indicate that the Kappa value obtained is 0.8055 or 80.5%. The validity of the model generated from the 2019 land use prediction map is 80%. This value shows that this modeling is classified as having a good similarity to the existing land use conditions in 2019.

3.2.3. Settlement Land Area Predict in 2028

Based on the classification results, Banyumanik District has 5 land use classes namely Settlement, Vacant Land Allocated, Vacant Land Not Allocated, Vegetation and Shrub. Predicted land use can be seen in the Figure 5 and area of each land use can be seen in Table 3.

Table 3: Land Use Area Predict 2028.

Name Sub district	Settle-ment	Vacant Land Allocated		Vacant Land Not Allocated		Vegetation		Shrub		Total (Hectare)		
Banyumanik	109,4	7,4%	13,1	5,9%	9,0	5,5%	43,4	3,7%	6,0	8,6%	180,9	5,9%
Gedawang	118,5	8,0%	26,8	12,2%	4,5	2,7%	145,4	12,5%	9,0	12,9%	304,1	9,8%
Jabungan	55,2	3,7%	4,8	2,2%	6,4	3,9%	247,3	21,3%	7,0	10,1%	320,7	10,4%
Ngesrep	167,4	11,3%	40,7	18,5%	12,8	7,8%	57,7	5,0%	0,2	0,3%	278,8	9,0%
Padangsari	61,7	4,2%	1,7	0,8%	6,8	4,1%	42,9	3,7%	0,3	0,4%	113,4	3,7%
Pedalangan	166,4	11,3%	10,0	4,6%	39,3	23,9%	56,7	4,9%	0,1	0,1%	272,5	8,8%
Pudak Payung	244,6	16,6%	79,5	36,1%	4,2	2,5%	307,2	26,5%	6,0	8,6%	641,4	20,8%
Srondol Kulon	128,5	8,7%	0,1	0,1%	4,4	2,7%	92,1	7,9%	0,5	0,7%	225,6	7,3%
Srondol Wetan	163,2	11,1%	10,2	4,6%	4,5	2,7%	41,3	3,6%	7,0	10,1%	226,2	7,3%
Sumurboto	140,2	9,5%	1,2	0,6%	10,7	6,5%	37,9	3,3%	5,0	7,2%	195,0	6,3%
Tinjomoyo	121,0	8,2%	31,8	14,5%	61,7	37,6%	88,7	7,6%	28,6	41,1%	332,0	10,7%
	1.476,1		220,0		164,4		1.160,6		69,6		3.090,8	

4. Conclusion

Changes in land use that occurred in the period 2011-2015, and 2015-2019 were dominated by reduced vegetation area, shrubs and vacant land not yet allocated, and the increase in the area of settlements and vacant land has been allocated. Changes in land use that occurred in the period 2011-2015, and 2015-2019 were dominated by reduced area of vegetation, underbrush and unallocated land, and an increase in settlement areas and vacant land has been allocated. The price of land in each village has increased land prices, both minimum and maximum. The increase in land prices in each period

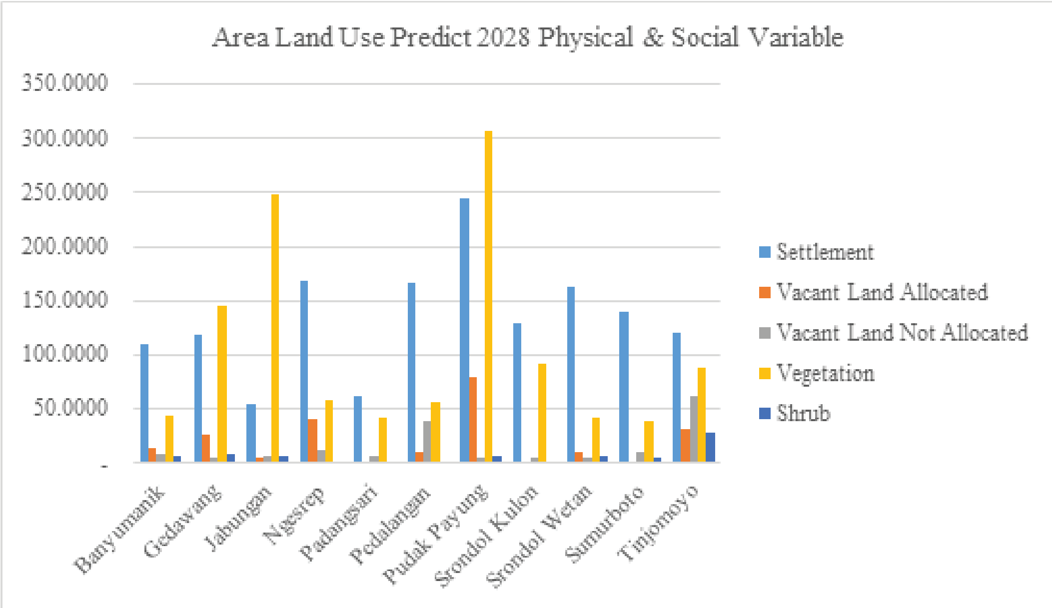

Figure 4: Land Use Area Predict 2028.

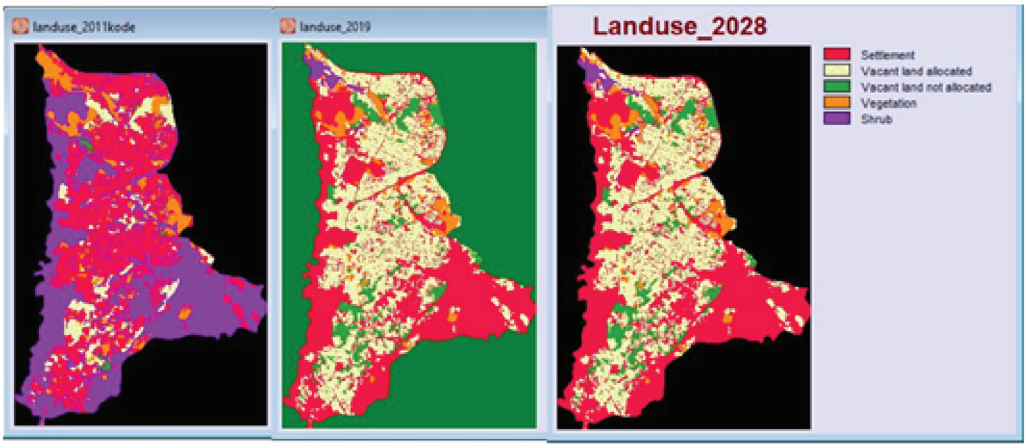

Figure 5: The results classify land use categories, 2011 (a), 2019 (b), 2028 using the Markov Chain prediction method (c).

was very high in Sumurboto District which is a central and business area. In this region, settlements that have commercial and strategic value also show very high land price increases. Modeling of land use change using the MLP-NN method at two years points (2011 and 2019) with driving variables namely physical and social-economic variables showing the results of the accuracy of the model is quite good (80.5%). Opportunities for vegetation, shrubs and vacant land have not been allocated to change into quite high settlements.

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