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Analysis of Changes Settlement and Fair Market Land Prices to Predict Physical Development Area Using Cellular Automata Markov Model and SIG in East Ungaran Distric

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Abstract. East Ungaran District has various forms of land use, from the many important land uses ranging from settlements, industry, roads and other public facilities. Over time, land use will have changes along with existing development. The development of the Semarang - Solo toll road in 2009 by PT Jasa Marga (Persero) Tbk and of changes the land use in the district and sub-district of West Ungaran, East Ungaran post-expansion area in 2003 is the factors causing land use change in East Ungaran Distric also conducted Analysis. East Ungaran District is one of the areas with the rapid development of the distric. This is the result of increased population and population mobility. Because of these factors, there is a growth of development as well as changes in settlemen that lead to the physical changes of the city. Based on above, it is necessary to research the settlement change in East Ungaran Distric. The method used to determine the hierarchy of rural and urban settlements with characteristics of the region which has the main function of cultivation of the livelihoods of its inhabitants, population density, facilities and infrastructure, the dominance of a broad percentage of land use. The method used to determine determine the direction pattern of the physical development of the the settlement area is Global Moran's Index while to predict the physical development of the East Ungaran Distric area in 2026 used CA Markov method. This research used high-resolution imagery in 2010 and 2018, and land use maps in 2002, 2010 and 2018. The data were used to analyze the settlement change. Meanwhile, the analysis of changes in land values using the land value zones map of 2002, 2010 and land value zones map of 2018 obtained from field survey results. This method will be assisted with field observations conducted in 2018, with the aim of giving an overview use changes that occur from these results, analyzed the effect of the settlement change on land value change in East Ungaran District as a result of Semarang - Solo toll road development.

***Keywords**: Settlement, fair market land value, CA Markov, Global Moran's Index, GIS.*

1. Introduction

The physical growth of the region is a major problem for some developing countries. One of them is Indonesia, which experienced serious problems in terms of population distribution that requires the land to support these activities. Growing regions will require space in this land as the land's physical development. East Ungaran District is one of the regions in Semarang Regency which has 10 villages, administratively the area of East Ungaran Sub-district of 61.7159 km² which is physically growing rapidly. East Ungaran Sub-district is an expansion of Ungaran Sub-district in 2005. The expansion of the region in Ungaran District is aimed at equitable development in the suburbs to facilitate the implementation of government tasks in the field of community service. The growth of the city towards the periphery, shows a strong link between urban and rural areas. Rural populations desperately need

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some municipal services such as education facilities, banking, agricultural facilities, health facilities and government administration services, while urban residents need the availability of food raw materials [2]. In 2009, Semarang-Solo toll road construction was completed 72.64 km by PT Jasa Marga (Persero) Tbk. One of the exit toll roads is located in East Ungaran Sub-district, namely the exit toll road which is part of the Semarang-Bawen segment already began operations in 2014. These conditions can be a cause of land use change. Land use change in the settlement class affects the change of land value from year to year. Research can be known whether the change of land use caused by toll road development affect the change of land price. The dynamics of land use change in East Ungaran District should be in line with the Spatial Plan (RTRW) of Semarang Regency, since RTRW is a space allocation guideline for the development of a region not beyond its carrying capacity [3]. To be able to predict future land use in spatial condition, spatial and dynamic based modeling is needed using Cellular Automata-Markov (CA-M) approach. The research was done by spatial approach to identify the development of physical space of settlement and increase of economic value of land (land price). The analysis is done quantitatively with the help of data obtained from direct field survey. The objectives of the research are as follows: (1) Identifying land use change in East Ungaran District in 2002-2018, (2) Identifying the development of urban and rural settlements in East Ungaran District in 2002-2018, (3) Identifying the development of fair market land prices in East Ungaran Sub-district in 2002, 2010 and 2018, (4) To estimate land use classification of shrubs in 2026, (5) Evaluate the synchronization of settlement land use in 2026 using Celluslar Automata-Markov (CA-M) approach to Spatial Plan District East Ungaran2011-2031 and see the potential problem.

2. Material and methods

2.1 Studi area

The area study of this research is in East Ungaran District, Semarang regency, Central Java, Republic of Indonesia. The area is located on the outskirts of the city and is at an average altitude of 400 meters above sea level. East UngaranDistrict located in the most northern region of the Central Government of Semarang Distric with hilly topography and residential areas. The boundaries of the District East Ungaran Distric are as follows : North is Semarang City, East is Demak Distric, South is Bergas District and Pringapus District, West is Ungaran Barat and Bergas District. Studi area of this research shown in Figure 1 below.

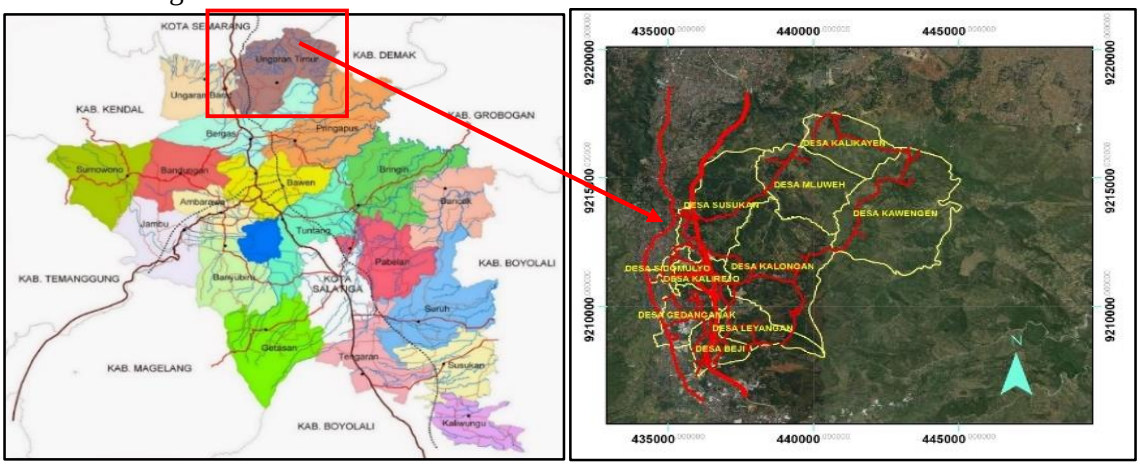


Figure 1. Map Administration of the East Ungaran District

2.2 Research data

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

a) Map RBI 1:25,000 1St edition in 2001 which are made from aerial photography on a scale of 1: 50,000 in 1999 from BIG (Badan Informasi Geospasial)
b) Rectified Quick bird imagery period 2010 and 2016.

c) High-resolution imagery from Google Earth period 2018
d) Map Administration of the East UngaranDistrict, Semarang from Bappeda Semarang Regency
e) Fair Market Land Prices in period 2002, 2010 and 2018 obtained from the field survey
f) Map Rencana Pola Ruang East UngaranDistric part of RTRW Semarang Regency in year 2011-2031 from district government Semarang.
g) While supporting data for examine the determinants of land use change, population, livelihoods and infrastructure facilities and consists of Potential Village data/Statistik data, East Ungarandalam angka in 2010 and 2017.

2.3 Data processing

The first research is digitizing on satellite imagery and analyzing land prices data processing for the stage of availability of settlements and changes in land prices. Methods of identification of settlements are visual interpretation and digitalization process on satellite imagery that have been corrected then visually interpreted by land use appearance characteristics and digitization to obtain settlement distribution. Visual interpretation aims to distinguish one theme with another theme based on the appearance described in the image data. Parameters used in visual interpretation are color, roof shape, size, texture, association (density between buildings), location or site, land pattern.

Digitizing on satellite imagery starting with preparations that include Quickbird high-resolution image procurement activities, image cutting, geometry correction, visual classification and field checking. Quickbird Images in 2010 and 2015 and updated with high-resolution imagery from Google Earth 2018 for 2010 and 2018 land uses. The 2002 land usage is taken from Map RBI 1: 25.000 Edition I in 2001 which is made from aerial photography on a scale of 1: 50000 in 1999 from BIG (Geospatial Information Agency). The downloaded image is then merged and cut to the outside of the East Jakarta Ungaran District administration map to focus on the research location. Furthermore the image is corrected geometry by using ground control point (GCP) with GPSagar measurement has the same coordinates. After geometry correction, visual classification is based on interpretation according to size, pattern, hue, texture and color in the image. Classification of observed land use is forest, mixed plantation, plantation, settlement, rice field, moor, vacant land, scrub and others. Classification was performed on all imagery of the year of observation to obtain land use map in 2002, 2010 and 2018. The second stage in this analysis is the stage of the analysis process. The method used in this step is to overlay the land use map all the years of observation so as to produce a transition matrix of land use change from year to year. Analysis of the development of settlements for the next 8 years in accordance with the RTRW of East Ungaran District is predicted to spread the settlement of East Ungaran District by 2026 using CA Markov Model. The prediction of land use change is processed based on the initial land use, suitability of the land and its neighbors. Cellular automata (cellular automata) is a simple model of the spatial distributed process in the GIS. The criteria for urban areas are determined by the characteristics of the region having the main function of non-agricultural cultivation or 75% of the population's livelihood in the urban sector, having a population of at least 10,000 people, having a population density of at least 50 persons per hectare, functioning as a collection center and distribution of services of goods and services in the form of facilities and infrastructure [4]. According to Shonkwiler J S and Reynolds J E [5], one way of determining urban areas, alteration and non-urban use is by using the percentage dominance of land use, "urban area" is an area where more than 60% of urban land use is non-agricultural. "Rural-urban area" is an area where most land use is dominated by forms of urban or non-agricultural land use (> 60% of land use is "urban land use" and <40% of land use is "ruralland use"). Whereas "rural area" is an area where more than 60% of land use is oriented towards rural or agricultural. Analyzing land prices done by analyze the fair market land prices data collect in 2002, 2010 and 2018. Before conducting field surveys must first do manufacture polygon (initial zone) on the satellite imagery available. In this study uses data initial zone that already exists for the East Ungaran District obtained from the government (BPN and BIG). The data collection was conducted using a sample. The samples referred to in the survey and mapping of the value of land is registered plot / land that provides the bid price or transaction information field of the land during the

period of 24 months for non-agricultural and 48 land last month for farmland. Attempted transaction price or offer in question is the buy or sale price. If no sale price (offer and transactions) can be used in the land rent. The sample of land price is obtained by purposive technique, which is based on the consideration of the characteristics of the village in the eastern ungaran district, proportionally with the use of residential, commercial and agricultural land which is reflected in the land value zone. The area of the land price zone is determined by an area of 10x10 cm multiplied by a scale of 1: 5000 with a minimum of 3 (three) samples, while for zones above 10x10 cm, a sample of at least 5 (five). For every 10x10 cm excess the number of samples plus 2 (two) and so on every multiple of 10x10 cm. The selected sample is fair market land prices transaction type and land price offer [6]. The method used is the method of calculating the stock value index / plot of unweighted price / equal weighted ground. From the land market value obtained, it is calculated the land prices Index in each zone of use area [6].

This research using 60 land value zones, with 331 sample of land parcels thats already direct surveys in period 2010 and 2018. The Land value data obtained from direct surveys need to get correction. The correction data in land values is to conduct market value analysis done to get the market land value of the transaction data. All data and purchase transactions are set at a certain valuation date, then the correction of the type and time correction data transactions of buying and selling to get a price estimate of land value. Adjustment of rights status, referring to the Circular of the Directorate General of Taxes SE 55 / PJ.6 / 1999 need to be adjusted price of land at the time of the transaction by paying attention to the status of land rights by using the reference as Certificates HM, HGB / HGU. Correction of time transaction for calculations until December 31th of the year in the calculation.

3. Results and discussion

The result of the settlemen on the digitized imagery in 2002, 2010, 2018 and Field survey results and data processing of fair market land prices in 2002, 2010 and 2018. The results from digitization of settlement classified as rural settlements and urban settlements. The results of field survey and data processing of fair market price of land in 2002, 2010 and 2018 obtained the average indication price or NIR. The NIR price of each zone of fair market land price is taken at its maximum price. Validation of land use result of digitasi done field check with number of observation point as many as 300 location. Examples of land use digits, toll road in high resolution satellite imagery and distribution of sample points for fair market land prices and field check land use surveys shown in Figure 2. The area of settlement digitized imagery results and fair market land price in the East Ungaran District shown in Table 1 and Table 2.



(a) (b)

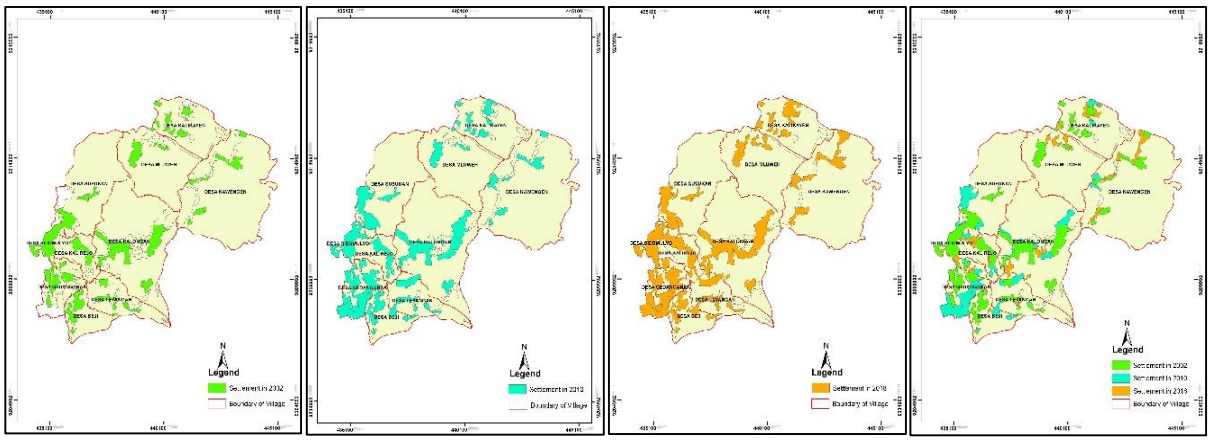
Figure 2. (a) Examples of land use digits, Toll Road in high resolution satellite imagery and (b) Distribution of 300 sample points for fair market land prices and field check land use surveys

Table 1. The area settlement and total changes 2002, 2010 and 2018

Villages Names	2002		2010		2018		2002-2010		2010-2018	
	Area (ha)	% area	Area (ha)	% area	Area (ha)	% area	Area (ha)	% area	Area (ha)	% area
Beji	48.64	0.83%	65.40	1.06%	68.04	1.11%	16.75	34.44%	2.64	4.04%
Gedanganak	66.99	1.14%	119.20	1.93%	129.97	2.11%	52.21	77.94%	10.77	9.04%
Kalikayen	50.39	0.86%	64.49	1.05%	88.63	1.44%	14.09	27.97%	24.14	37.44%
Kalirejo	44.75	0.76%	57.05	0.93%	82.66	1.34%	12.30	27.50%	25.61	44.89%
Kalongan	152.07	2.59%	209.36	3.39%	234.62	3.81%	57.29	37.68%	25.26	12.07%
Kawengen	57.03	0.97%	68.98	1.12%	113.44	1.84%	11.95	20.96%	44.46	64.44%
Leyangan	40.94	0.70%	61.71	1.00%	70.80	1.15%	20.77	50.73%	9.10	14.74%
Mluweh	46.50	0.79%	46.55	0.75%	67.40	1.10%	0.04	0.09%	20.86	44.81%
Sidomulyo	76.90	1.31%	77.68	1.26%	85.25	1.39%	0.79	1.03%	7.57	9.74%
Susukan	51.15	0.87%	108.90	1.77%	127.40	1.74%	57.75	112.90%	18.50	36.17%
Total	635.36	10.83%	879.32	14.26%	1,068.22	17.03%	243.95	38.40%	168.91	19.21%

Information : The results from process calculated the total area per village.

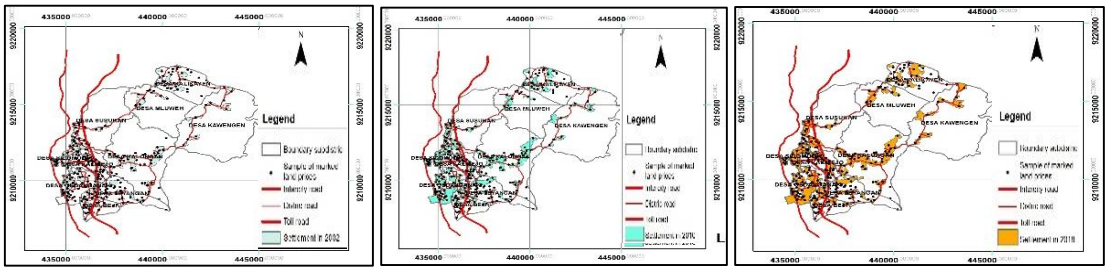
The ilustration for settlement in East Ungaran District in period 2002, 2010 and 2018 show in Figure 3.



(a) (b) (c) (d)

Figure 3 (a) The availability of settlement land in 2002 delineation results in Map RBI 1:25.000 Edisi I in 2001 which are made from aerial photography on a scale of 1: 50000 in 1999 and (b) in 2010, (c) in 2018 delineation results in high resolution imagery and vector data in 2010 and 2018 and (d) overlay results 2002, 2010, and 2018.

Conducted overlay settlements with data processing results fair market land prices field survey results to analyze the maxsimum and minimun prices in each village. Processing fair market land prices by adjusting bid price data by 10%, type of land status by 5% -10% and time of survey on 31 December in the current year by 10%. The result of the maxsimum and minimun prices in each village can be shown in Table 2. The result of overlay of settlement distribution and the position of the sample point can be shown in Figure 4.

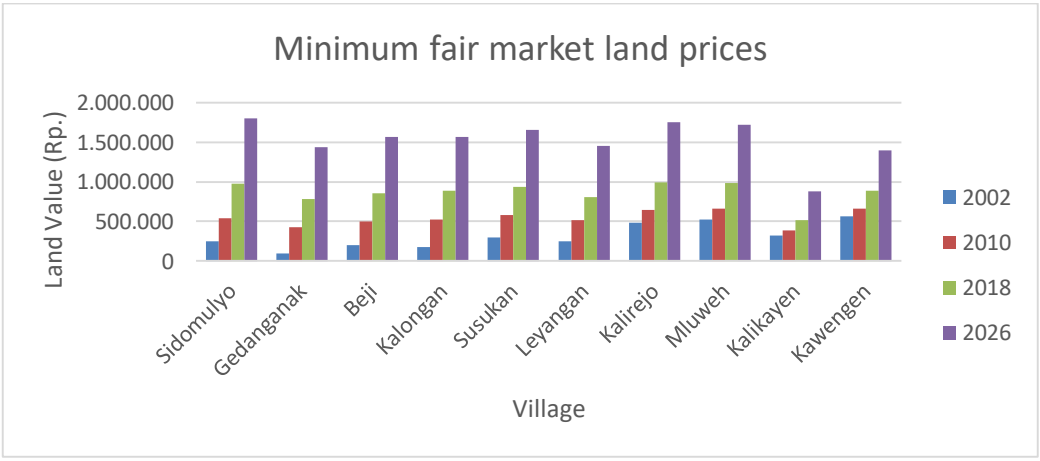


(a) (b) (c)

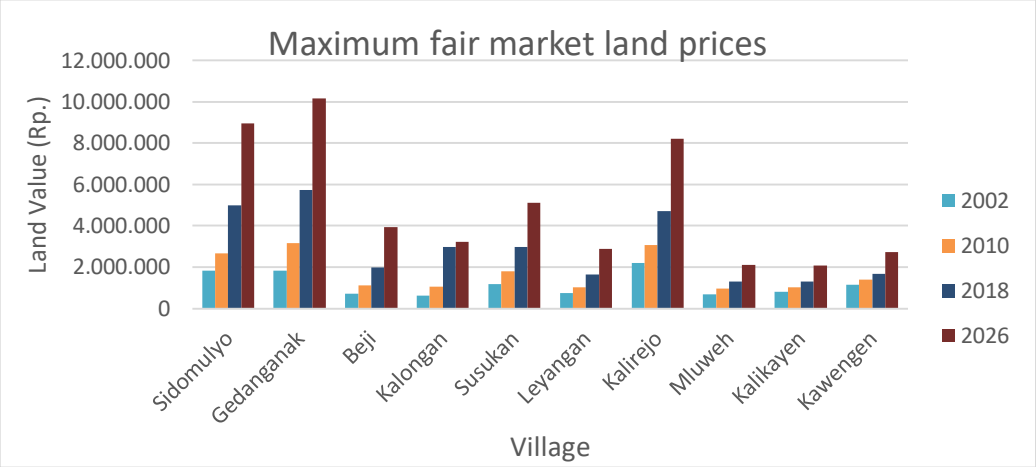
Figure 4. Maximum fair market land prices every village in year (a) 2002, 9B) 2010 and (c) 2018

Table 2. The result of data processing of fair market land prices in 2002, 2010 and 2018

Villages Name	Minimum Fair Market Land Prices (Rp.)				Maximum Fair Market Land Prices (Rp.)			
	2002	2010	2018	2026	2002	2010	2018	2026
Sidomulyo	248.100	542.700	976.400	1.801.308	1.815.700	2.669.100	4.978.400	8.939.940
Gedanganak	95.500	428.300	778.800	1.437.163	1.829.000	3.170.700	5.724.700	10.154.066
Beji	199.000	502.500	856.300	1.565.520	719.000	1.106.900	1.974.600	3.940.000
Kalongan	177.600	520.700	885.200	1.567.060	632.700	1.060.100	2.968.500	3.208.700
Susukan	295.300	580.000	938.600	1.653.388	1.188.900	1.808.300	2.968.500	5.111.108
Leyangan	245.600	513.000	806.500	1.454.334	751.400	1.028.000	1.631.400	2.886.317
Kalirejo	483.200	647.400	993.500	1.750.272	2.197.500	3.070.000	4.714.800	8.207.156
Mluweh	525.400	656.800	985.100	1.718.607	669.300	973.500	1.310.100	2.118.006
Kalikayen	324.800	389.700	515.100	877.400	794.400	1.036.400	1.286.300	2.083.210
Kawengen	563.800	659.700	885.200	1.395.820	1.139.300	1.392.100	1.678.400	2.728.414



(a)



(b)

Figure 4. Minimum (a) and Maximum (b) fair market land prices every village

From the Figure 4 can be seen that all villages in East Ungaran experience an increase in fair market land prices, both minimum and maximum. Respectively villages experiencing the highest rise in land prices ranging from Gedanganak, Sidomulyo. Susukan and Kalirejo at a price of more than 4 million per square meter. While villages that experienced the lowest price increase in a row included the village of Kawengen, Kalikayen, and Mluweh at a price of less than 4 million per square meter. To obtain the quality of the sample data of each zone is limited by selecting data that meets the star deviation by 30%. The large standard deviation of processing results is shown in Table 3.

Table 3. The large standard deviation of processing results

Villages Name	Number Sample	Number Zone	Standard Deviation		
			2002	2010	2018
Sidomulyo	9	26	7.8%	8.8%	10.2%
Gedanganak	12	42	12.8%	12.5%	14.9%
Beji	10	31	13.4%	13.0%	14.0%
Kalongan	8	43	13.0%	14.0%	15.0%
Susukan	9	29	10.3%	11.3%	12.3%
Leyangan	9	34	13.9%	13.3%	12.4%
Kalirejo	9	32	15.4%	17.6%	17.8%
Mluweh	4	12	10.8%	11.8%	12.8%
Kalikayen	10	29	12.8%	13.8%	14.3%
Kawengen	3	8	27.4%	28.4%	29.4%

The development of East Ungaran district can be seen also from the increase of several parameters, such as the increase of population, the increasing number of public facilities, the increasing number of paved roads, and the extent of agricultural land based information from BPS Ungaran Timur. So that the area can be categorized as developing from village to city. The following table is the development of some parameter changes based on the statistics area as shown in Table 4.

Table 4. Parameter of area development in East Ungaran District.

No.	Village Name	Number of Education Facilities		Asphalt Road Length (Km)		Total population		Land Area (Ha)			
								Agriculture		Non-Agricultural	
		2010	2017	2010	2017	2010	2017	2010	2017	2010	2017
1	Beji	12	12	7,50	7,50	7.990	8.977	81,40	105,00	135,60	107,42
2	Leyangan	4	4	1,50	6,50	4.598	10.851	81,00	103,58	122,10	178,48
3	Kalongan	14	18	18,00	18,00	7.921	11.160	137,00	668,34	731,40	218,78
4	Kawengen	12	12	10,00	11,60	6.212	6.072	113,74	307,36	634,26	374,97
5	Kalikayen	3	3	6,20	6,20	3.344	3.757	119,60	225,26	203,70	779,18
6	Mluweh	7	10	2.3	2,30	3.791	4.183	109,70	340,17	315,10	387,49
7	Susukan	9	9	30,00	30,00	7.097	10.882	36,00	91,09	268,00	228,63
8	Kalirejo	7	10	5,00	5,30	3.523	4.308	73,50	159,13	230,50	212,52
9	Sidomulyo	11	11	9,00	9,60	3.601	4.599	12,50	42,62	104,30	74,19
10	Gedanganak	9	12	6,00	7,00	12.834	15.300	70,00	88,55	219,70	206,42

Seen from the table 4, from the parameter conditions can be said that the areas included in the category of cities in 2010 are Beji, Gedanganak, Sidomulyo, Kalongan,and Kalirejo. While those included in the category of villages are Susukan, Kawengen, Kalikayen and Mluweh. Based on parameter conditions changes in 2017, it can be seen that the areas into the category of cities are Beji, Gedanganak, Sidomulyo, Kalongan, Kalirejo and Susukan. While those included in the village category are Kawengen, Kalikayen, and Mluweh. This category is supported by changes in the physical appearance of the region that changes. Such changes include vacant land into settlements. this condition is in accordance with the spatial plan of East Ungaran region included in the village called rural settlement, while urban settlements are called urban settlements, as shown in Table 5.

Table 5. The area urban settlements and rural settlement 2010 and 2017 in East Ungaran District

No.	Village Name	Settlement area (Ha)		Category of Settlement Areas	
		2010	2018	2010	2018
1	Beji	65.40	68.04	Urban Settlement	Urban Settlement
2	Gedanganak	119.20	129.97	Urban Settlement	Urban Settlement
3	Kalikayen	64.49	88.63	Rural Settlement	Rural Settlement
4	Kalirejo	57.05	82.66	Urban Settlement	Urban Settlement
5	Kalongan	209.36	234.62	Urban Settlement	Urban Settlement
6	Kawengen	68.98	113.44	Rural Settlement	Rural Settlement
7	Leyangan	61.71	70.80	Urban Settlement	Urban Settlement
8	Mluweh	46.55	67.40	Rural Settlement	Rural Settlement
9	Sidomulyo	77.68	85.25	Urban Settlement	Urban Settlement
10	Susukan	108.90	127.40	Rural Settlement	Urban Settlement

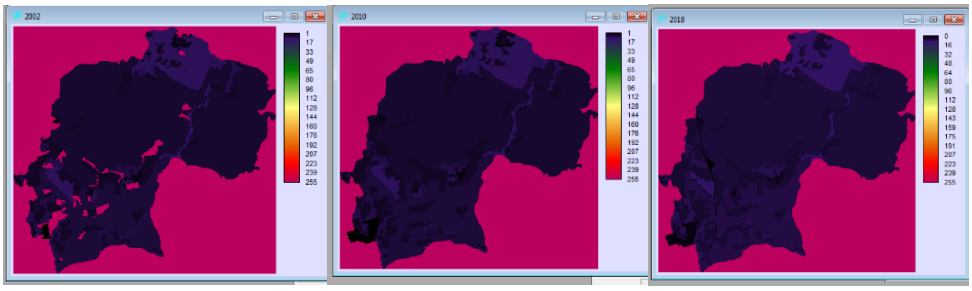
Visually, the identification process through satellite imagery, there are changes in land use for housing in several regions, these changes can be seen in the following figure. The area of settlement digitized imagery results in the East Ungaran District shown in Figure 5.



(a) (b)

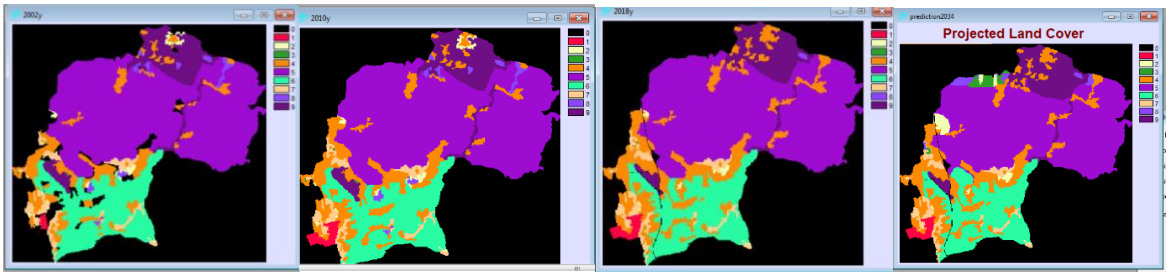
Figure 5. settlement imagery in East Ungaran District

Analysis of the development of settlements for the next 8 years in accordance with the RTRW of East Ungaran District is predicted to spread the settlement of East Ungaran District by 2026 using CA Markov Cellular Automata Markov prediction is usually used to predict the development of a region's changes according to its land use class. The results of the processing show in Figure 6, Figure 7.



(a) (b) (c)

Figure 6. Results of Conversion of Vector Data to Raster for Land Use (a) 2002, (b) 2010, (c) 2018



(a) (b) (c) (d)

Figure 7. The results classify land use categories (a) 2002, (b) 2010, (c) 2018 and CA Markov Storage is a projection in 2026

The results of the CA Markov Model are converted into vectors for analysis of settlements and compared with the condition of settlements on the map of the Spatial Pattern of the Spatial Plan of East ungaran District. Map The spatial pattern of RTRW Ungaran East Distric is shown in Figure 8.

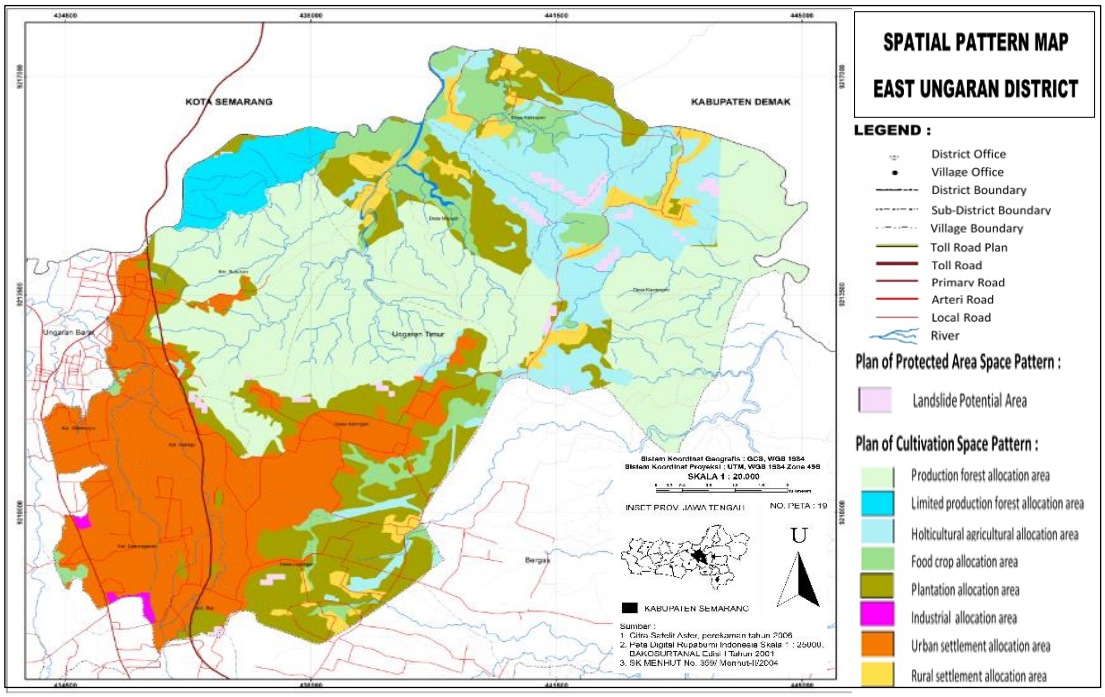


Figure 8. Map The spatial pattern of RTRW Ungaran East Distric

4. Conclusion

Based on this research, it can be concluded that the settlement and land value in the East Ungaran District, Semarang during the period of the year 2002 and 20346 increased the number of extents. Type vacant land that increasing is the number of settlement. Total area of the availability of vacant land has decreased in every sub district has a varied value. The decline in the number of settlement that most are in East Ungaran district with a total area change of 559,198.7 square meter with percentage 33.3%. This happens because the vacant land change for the construction of settlements. As the decline in the number of settlement from period 2010 and 2016, the land value is also increasing, it can be seen in the increase in land value in all areas of research. So it can be identified that the development of the region and physical development in East Ungaran district, Semarang most are in East Ungaran Subdistrict, it can be seen on the vacant land use changes that occur in the region. Phenomena that occur is the existence of toll road Semarang-Solo. The existence of toll road in this suburb as a form of the development of the city that was equitable development with the spread of urban facilities. The Results of this research that is the existence of toll road Semarang-Solo influenced the development of settlement in East Ungaran District. For the whole region in East Ungaran is affected by the existence of the toll road.

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