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Spatial Modeling of Settlement Development Pangururan-Simanindo District

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Abstract. Pangururan-Simanindo are two districts located in Samosir regency. Pangururan is the capital of Samosir Regency and Simanindo located at the main entrance to Samosir Island. Spatial modeling for settlement suitability can be done by looking at changes over the past 15 years by analyzing driving factors that influence the development of settlements such as distance to the road, distance to Lake Border, point of inters and slope. Processing of remote sensing data and tabular data for spatial modeling of settlements in Pangururan-Simanindo is done by utilizing geographic information system application using Cellular automata method. The purpose of this study is to analyze the development of settlements in Pangururan-Simanindo in 2007-2018 and see spatial patterns of settlements Pangururan-Simanindo City in 2007-2018.
Keyword : Samosir, Cellular automata, settlement

1. Introduction

Nowadays, population growth is increasing every year. Indonesia's population growth is recorded at more than 262 million people on in 2017. This population growth data can be classified as incorrect an early warning system for the government in terms of providing land for settlement. Just like most cities in Indonesia, Pangururan Regency also experiencing an increase in population every year. According to the distribution residents of each sub-district, the population development of Samosir Regency, which is 30,468 souls (24.61 percent), with a population density reaching 250.91 people / km2 in 2017. As the capital city of Samosir district, of course the development settlement becomes an interesting thing to study, because by knowing the direction the development of Pangururan city can be done more structurally in land use and empowerment.

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In Law Number 4 of 1992 concerning housing and settlement, housing is defined as a group of houses that function as living environment or residential environment equipped with facilities and infrastructure. Physically housing is an environment that consists of collection of residential units where social interaction is possible among its inhabitants, and equipped with social, economic, cultural, and infrastructure service which is a subsystem of the city as a whole. This environment usually have rules, habits and a value system applies to its citizens. Understanding housing is often associated with development a number of houses by various government and private institutions with designs the same or almost the same housing units. Number of houses and groups This housing is not certain, it can consist of two or three houses or it can alsonup to hundreds of homes. The shape is not limited to one-story buildings only, which is lined horizontally, but can also be a building multilevel is a flat.

Development of settlements in a region in the future can be predicted based on existing facts or data in the region. Cellular Automata (CA) is a discrete agent-based method, commonly used in cell based applications that are most widely used to simulate land use change in the past few decades. Cellular Automata is a simple model of the process spatially distributed (spatial distributed process) in GIS. Data consists of an arrangement cells (grid), and each is arranged in such a way that only allowed to be in one of several conditions. Land use model using CA has been applied as a tool to support land use planning and policy analysis and exploring scenarios for future development [1]. Modelling with Dynamic system approaches have dynamic properties in time, so they can predict future time conditions. As for modelling based spatial and dynamic, can be done with the Cellular Automata Markov approach (CA-M). This model can predict future conditions spatially.

Spatial modeling for settlement suitability can be done with see the change in Panguruan-Simanindo Sub district for a period of 15 years back and with the driving factor analysis or driving factor affect the development of settlements. Remote sensing data processing and tabular data for the spatial modeling of Panguruan-Simanindo District Settlements This is done by utilizing geographic information system applications with using the Cellular automata method. The purpose of this study is Analyze the pattern of land cover change in Pangururan-Simanindo District in 2007, 2011, 2018 and analyze the spatial model of settlements in Panguruan-Simanindo District in 2007-2032.

2. Method

2.1 *Research Area*

This research was conducted in Samosir Regency by taking the area Panguran-Simanindo District. Pangururan District has an area: 121.43 km² is divided into 25 villages 3 villages with population density: 250.91 soul / km2 in 2017. While Simanindo sub-district has an area of 198.20 Km2 senga total population of 19,814 people and reach a density of 99.97 people / km2 Here are the limits of Pangururan-Simanindo City:

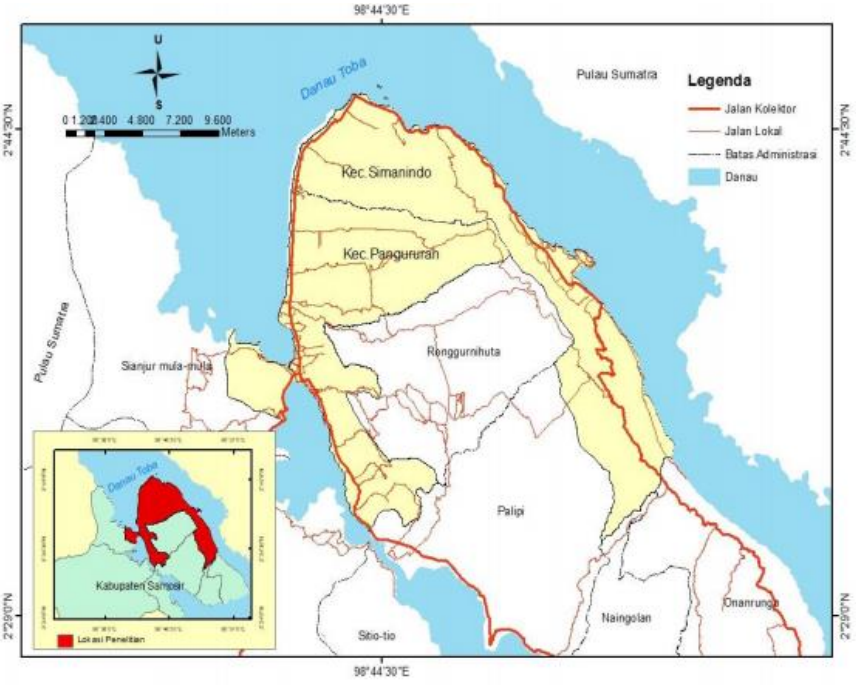

Figure 1. Research Sites (Panguruan-Simanindo District)

2.2 Research Thinking Flow

Panguruan-Simanindo has greater potential than in other sub-districts in Semosir Regency because it is the center of government as well as infrastructure and there is more adequate accessibility in this city. The population of Panguruan-Simanindo reaches 250.91 people / km2 in 2017 resulted in changes in land use. Development settlements certainly will also continue to grow with increasing numbers availability of public facilities in this city. The variables used to see the development of the Panguruan-Simanindo is by looking at the relevant point of interest with public facilities such as places of worship, education centres, government centres as well as health centres. Other variables used are distance, distance lake border and slope. Use of this variable because is the main reason for the selection of settlement locations.

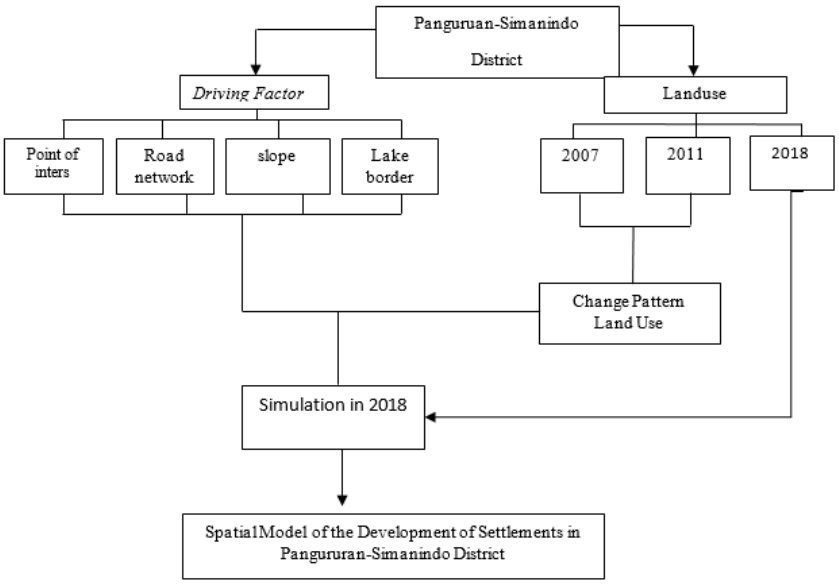

Figure 2. Research thought flow diagram

2.3 Data Sekunder

Identification of land cover using Landsat imagery which is the result of downloads from USGS, with a resolution of 30 x 30 meters per pixel unit. Other secondary data included in the variable data are obtained from agencies that issue related data. For more details, see table 1.

Table 1. Types and sources of secondary data

Data	Source
Landsat	Landsat 2008, 2011, and 2018 (USGS)
Land cover	Digitation on screen Landsat
Administrative District of Pangururan-Simanindo	BAPPEDA
Lake border	BAPPEDA
Road network	BAPPEDA
Slope	RBI Samosir

Map RTRW Kabupaten Samosir	BAPPEDA

2.4 Data processing

Data processing is carried out in three stages, namely the processing of multi temporal image classification data, data processing driving factors, and the making of prediction models.

2.4.1 Multi Temporal Image Classification

In the first processing stage, image classification is carried out using image processing software (Envi 5.1), using Remote sensing techniques, here are the work steps performed in the first stage of processing. The image that will be processed is Landsat imagery. At the processing stage in the ENVI software that is done the layer stacking which is useful for combining each band which displays the appearance of a land cover or true color. Layes stacking is only done on my Landsat image. But the process for cutting the image sheet, applied to both types of images. Cut the image using a spatial subset with polygon region boundaries determined by members who must cover the study area. Furthermore, after going through the cutting and sharpening stages of the image then the digitization stage is done in ArcMap 10.1. Perform digitization land cover is based on the existing image.

2.4.2 Driving Factors Processing

This data processing is the processing done using spatial data processing software (Arcgis 10.1), using spatial data processing techniques, in this processing, will issue one output containing all driving factors. Prepare variable data which will be used then cut each data using the limit Panguruan-Simanindo District administration ensures that administration is used to cut this data, just like the administration used in the image processing stage. After cutting then the next is doing data processing by entering classification of each variable.

Lake border is the area of land that surrounds and a certain distance from the edge of the lake which is designated as an area lake protector. The lake border is considering the location research surrounded by Lake Toba. Classification of distance from the road is an important reference in determine the direction of development of settlements. Road is main considerations in the construction of settlements. Taking this road classification researcher adjust to topographic conditions and applicable policy at the location of the researcher. Recalling presidential regulation 51 in 2014 which regulated the lake border, then the road distance was also adjusted at least 50 meters from the lake. In the classification of distances from the point of interest (hospitals and schools), researchers used previous research from [2], which modified with a little change, because in his Ozturk study categorize the industry as a point of inters, but in this study, the author does not use industry as a variable.

2.4.3 Model prediction

Spatial modelling of land use changes done on modelling software (IDRISI Selva 17), which is powerful software created by Prof. Ron Eastman (2003). The software combines digital image processing capabilities and raster-based GIS which is very useful in spatial modelling image based. Spatial modelling is used with the Land Change Tool Modeller (LCM) on IDRISI devices. The LCM tool can analyse land use change in the past, modelling it land use change, predict future changes. So it is expected to use this tool the author gets results in accordance with the research objectives.

3. Result

3.1 Land cover conditions in 2007, 2011 and 2018

Table 2. Area of Land Cover

Landcover	Area of Land Cover (ha)			
	2007	**2011**	**2018**	**2032**
Settlement	7568,714	12277,134	13698,66	20234,21
Non-Agricultural Areas	11578,67	10342,96	8699,93	5236,43
Agriculture Area	10991,35	9924,80	7253,97	5822,00
Empty land	3072,71	1299,26	1763,43	1586,21

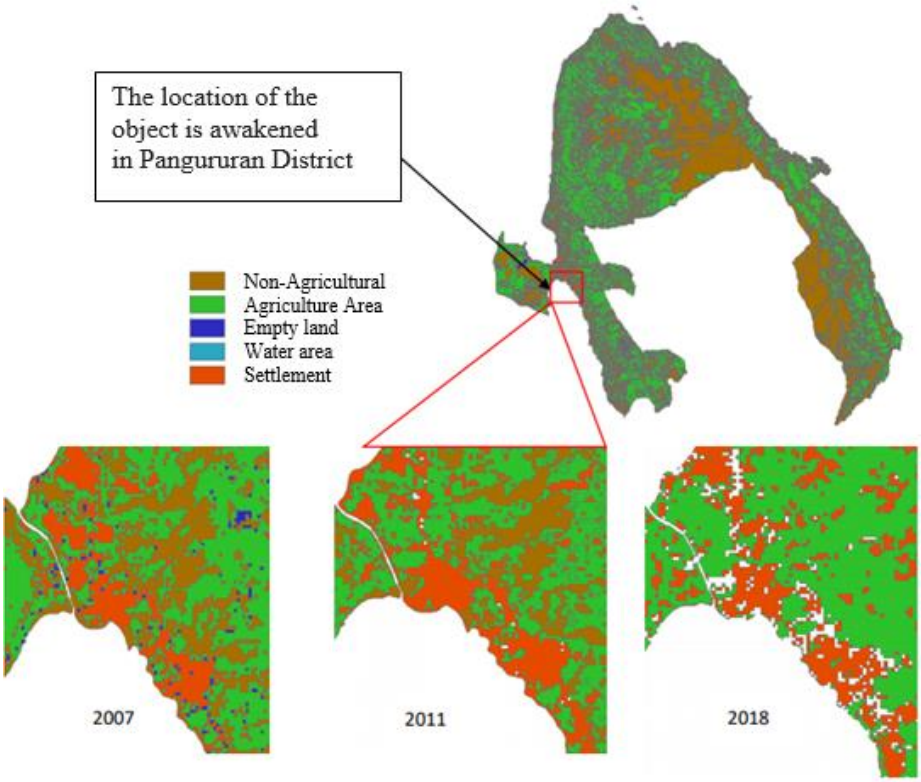

Figure 3. Description of Object Changes Built in Pangururan District

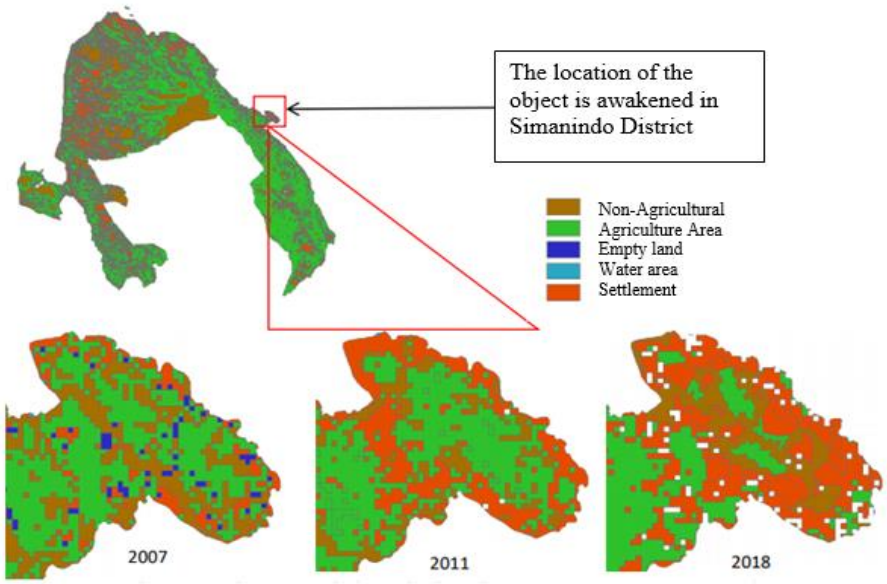

Figure 4. Object Change Image Built in Simanindo District

3.2 Prediction model in the direction of development of the settlement of Pangururan-Simanindo Subdistrict

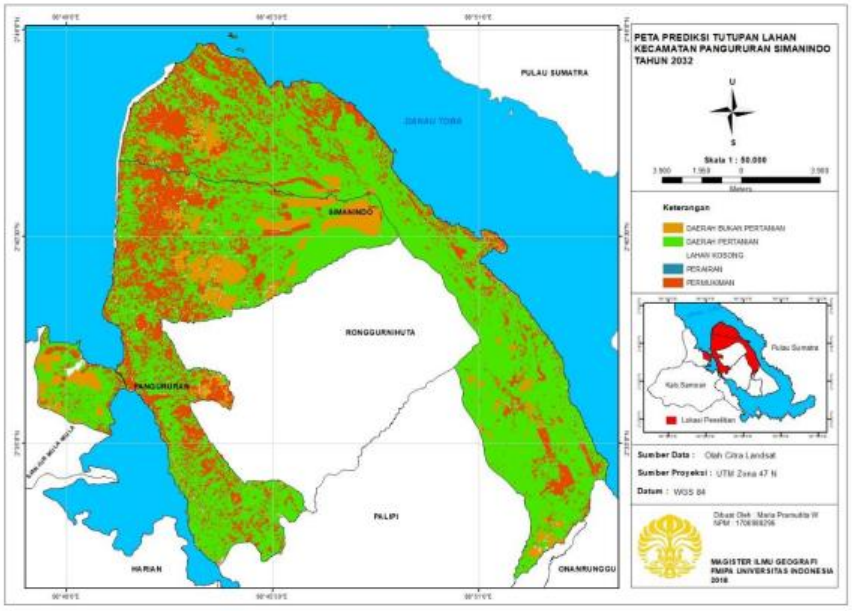

Figure 5. Land Cover Prediction Map of Pangururan-Simanindo District

4. Discussion

The condition of land cover at the study site experienced sufficient changes significant, can be seen from a map of color changes that signify regional changes not agriculture is getting bigger. The area of non-agricultural areas originally had area of 11578.67 ha in 2007 to 8699.93 ha in 2018. To cover settlement land also underwent changes, from the initial settlement area 7568,714 ha in 2007 to 13698.66 ha in 2018. For more details, can be seen in table 2 Area of land cover. Pangururan District, which is the capital of Samosir Regency, has great potential for changes in land cover of settlement objects. In Figure 3, the location adjacent to the center of the capital of this area experienced quite a lot of changes from 2007-2018. On the 2007 map, there can be seen that there are still many non-agricultural land cover areas which, if seen in the field, are forests, the number of years is decreasing and replaced by settlement land and agricultural areas. When seen in the field, indeed, in this location, there are many settlement locations bordering directly with plantations or the use of land can be entered into mixed garden objects.

Simanindo District is a sub-district that is directly adjacent to Pangururan sub-district. Simanindo District has the attraction of cultural attractions which is very famous on Samosir Island and this location is close to the moat Tomok which is the main access to Samosir Island from the direction of Sumatra Island or Medan, in Figure 4 can see a very drastic change in land cover in 2007 and 2018. Land cover for residential objects was very dominant change of land. The location taken on the map is the Tuk-tuk Siadong tourist area, where at this location there are many inns and restaurants. On the map, encountered land changes which in 2007 were objects of agricultural areas and in 2018 it turned into a non-agricultural area land cover. Under conditions in the field it was found that most objects that were close to these settlements were object of using bush land. Therefore this location in 2018 area agriculture turns into a non-agricultural area.

Modeling to predict land cover in 2032 in the District Pangururan-Simanindo Figure 5 is done by using a driving factor which is a variable physical conditions, infrastructure variables and land cover variables. This prediction map shows the tendency of settlements to develop in which northern regions away from the city center. It also shows the possibility of development settlements go east which if seen from the physical condition variable towards the east or the middle part of Samosir Island has an altitude of more than 800 mdpal. And the conditions in the field at this time show that there is development heading east from Panguran District or in the Parbaba area, which area this will be used as the administrative center of Pangururan City.

5. Conclusion

The condition of land cover changes in Pangururan-Simanindo District shows that in residential objects and agricultural areas, there has been a broad increase from in 2007 to 2018. As for the objects of the area not agriculture and land blanks experience extensive reduction. Locations that are considered strategic in the District Pangururan experienced an increase in the size of residential objects in 2018, which one in 2007 the location was dominated by non-agricultural area land cover. In locations that are considered strategic in Simanindo Sub district, there is an increase area of settlements in which the object is

found lodging and restaurant. Modelling to predict changes in land cover in the District Pangururan-Simanindo got the result that the movement of settlement objects tended to be developed northward from Pangururan District and headed eastward where the object of land cover that changes the most is non-agricultural areas turned into an agricultural and settlement area.

6. References

[1] Ministry of Environment and Forestry. (2016). Encouraging Development Lake Toba as a Priority Tourism Destination. Research Agency, Development and Innovation of the Social Research and Development Centre, Economics, Policy and Climate Change. Vol. 10 No.3 of 2016 ISSN: 2085-787X

[2] Kusratmoko, E., Albertus, SDY., Supriatna. 2017. Modelling land use/cover changes with markov-cellular automata in Komering Watershed, South Sumatera. *IOP Conf. Series: Earth and Environmental Science. Volume 54, No. 012103*

[3] Ozturk, Derya. (2017). Modelling spatial changes in coastal areas of Samsun (Turkey) using a cellular automata –markov chain method. *Tehnicki vjesnik. Volume 24 (1), pages 99-107*

[4] Republic of Indonesia Presidential Regulation Number 81 of 2014 concerning the Spatial Planning for Lake Toba Region

[5] Republic of Indonesia Law of the Number 4 of 1992 concerning Housing and Settlement

[6] Republic of Indonesia Law Number 1 of 2011 concerning Housing and Settlement Area

[7] Teddlie, Charles., Yu, Fen. 2007. Mixed Methods Sampling: A Typology with Examples. *Journal of Mixed Methods Research. Volume 1 (1), pages 77-100.*

[8] Van Vliet, J., White, R., & Dragicevic, S. (2009). Modeling urban growth using a variable grid cellular automaton. Computers, Environment and Urban Systems, 33(1), 35-43.

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