JOURNAL OF APPLIED GEOSPATIAL INFORMATION

Vol 6 No 2 2022

http://jurnal.polibatam.ac.id/index.php/JAGI
ISSN Online: 2579-3608

Evaluation of Settlement Space Patterns in Solok City with Remote Sensing

Siti Naila Tassa Ghuba Afti[1]*, Fitriana Syahar[2]
*Corresponding author e-mail: fitriana.syahar@fis.unp.ac.id
[1,2]Study Program of Remote Sensing Technology– Padang State University

Received: September 01, 2022
Accepted: November 02, 2022
Published: November 02 , 2022

Abstract

Land use is the physical form of the earth's surface that is influenced by human activities. The increase in population results in changes in land use for settlements that tend to increase and are not controlled, so it is necessary to monitor the rate of these changes so that the balance of life and the environment can be maintained and in accordance with what has been regulated by the government in the regional spatial plan (RTRW). This study aims to identify changes in settlement area from 2010-2020 in Solok City and assess the suitability of land use for settlements with residential spatial patterns (RTRW) in 2012-2031 Solok City. This study uses remote sensing data in the form of spot images. The steps taken by the image interpretation approach with manual digitization methods and arcgis applications, accuracy sampling is done by random sampling with the confusion matrix accuracy test technique carried out to answer the goal. The results of the study found that the image accuracy was 91.66%. Then, the condition of settlements in Solok City continues to increase in area every year in the 2010-2020 period with a total of 353.8 Ha, where the largest area of settlement changes is in Lubuk Sikarah District. In this study, it can be stated that the area of settlement in 2020 is 306.50 Ha which is not in accordance with the area contained in the spatial pattern (RTRW) of Solok City.

Keywords: Solok City, Remote Sensing, Settlement, Space Pattern

1. Introduction

The spatial pattern is a form of regional spatial planning that has been regulated by the government to control land use in accordance with its designation. Land use is all forms of human intervention on the earth's surface space due to human activities, either simply or using technology aimed at meeting human needs (Arafat, Yunaf and Marliantoni, 2021). Changes in land use will be uncontrolled due to many factors, one of which is an increase in population. This triggers an increase in the need for land so that it has an impact on increasing the area of settlements. Solok City in the spatial pattern that has been determined by the government has an area developed for cultivation of 67.46% of the total area. Dubbed as a rice-producing city, however, the development of settlements that occurred in Solok City is slowly changing agricultural areas into residential areas that are not in accordance with spatial patterns. The impact is a reduction in the area of rice fields in Solok City which results in a decrease in rice production (Ramadina and Ayesha, 2019).

The above factual conditions must be monitored for progress so as not to exceed the limit. Remote sensing technology is developing rapidly and its practice is very helpful in spatial planning work, among others, to monitor land use. Spot image is one of the resolution remote sensing data that provides two identical high resolution imaging instruments with panchromatic (P) and Multispectral (Green, Red, and Near Infrared). The spot image has a spatial resolution of 2.5 meters-10 meters with a wide viewing angle which covers 60 x 60 km or 60 x 120 km in twin infrastructure mode so as to provide accurate data for good detection (Magdalena et al., 2021).

From this explanation, it is important to conduct a study on how to use the developed area with a spatial pattern plan (RTRW), namely high-resolution satellite imagery so that the dynamics of changes made in Solok City can be monitored regularly.

So, this research was conducted to find out how big the suitability of the settlement area in 2020 with the spatial pattern of settlements in 2012-2031 in Solok City.

2. Methods

2.1. Time and Location of Research

This research was conducted in Solok City, which is one of the cities located in West Sumatra province consisting of 2 sub-districts and 13 urban villages with an area of 57.64 km2 which is located at an altitude of

514 m with a population of 73,438 people in 2020. The location can be Let's take a look at the map below:

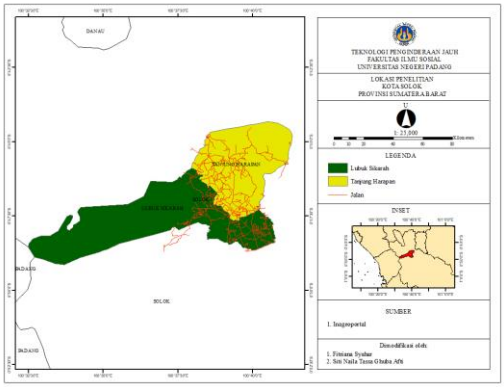

Figure 1. Research Sitemap

2.2. Data Analysis Method

The data analysis technique for measuring changes in settlement area and determining its suitability with spatial patterns (RTRW) is overlaying and identifying settlement developments using an image interpretation approach with manual digitization, so that a settlement map is generated every year of observation. Land use classification in this study uses a classification according to (Malingreau, 1978) which consists of 7 classes, namely forest, settlements, mixed gardens, rice fields, shrubs, open land and water bodies. Sampling in this study to test the accuracy in the field using random sampling technique, the sample size is determined in this study by the formula (Fitzpatrick-Lins, 1981), with an accuracy level of 90% and an error rate of 10%, as follows:

$$N = \frac{22 \times 90 \times 10}{10^2} = 36$$

Information:
N = number of samples
Z = standard deviation of normal whose value
2 p = expected accuracy
q = 100 – p
E = error received

The distribution of sample points was determined for each type of land use randomly using a Geographic Information System (GIS). Meanwhile, the accuracy test was carried out using a confusion matrix (Oldenborger and Short, 2022) and a modified Kappa coefficient to test the accuracy of visual interpretation.

3. Discussion Results

From the results of image interpretation with manual digitization, it is found that the City of Solok experiences changes in land use every year. The results of each of these changes are as follows:

3.1. Identify Changes to Settlement

a. Land Use

1) Solok City Land Use Using Spot Year 2010

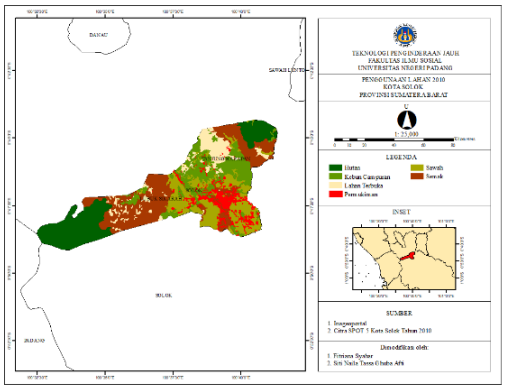

Figure 2. Solok City Land use in 2010

2) Solok City Land Use Using Spot Year 2015

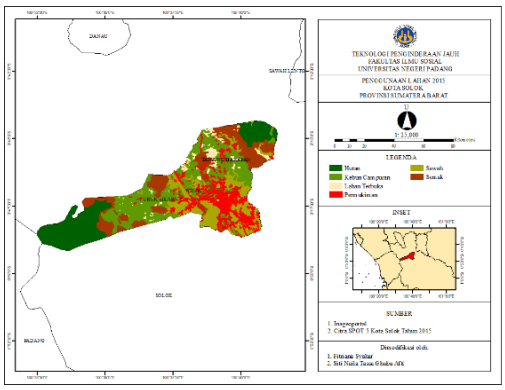

Figure 3. Solok City Land use in 2015

3) Solok City Land Use Using Spot Year 2020

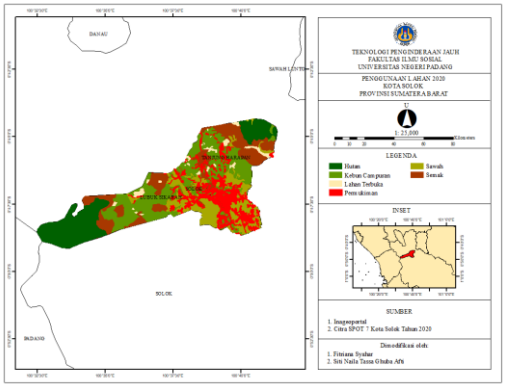

Figure 4. Solok City Land use in 2020

Based on the land use maps of 2010, 2015 and 2020 scale 1:25,000 obtained from the interpretation results, there are seven land use classes in Solok City that have been identified and their area

calculated using geometric calculations as shown in the following table:

Table 1. Area of Solok City Land Using

Land Use Classification	2010	2015	2020
Forest	1291,87	1216,53	1194,40
Mixed Garden	1055,43	1511,95	1838,38
Open Field	564,84	229,73	170,68
Settlement	459,16	665,47	812,96
Ricefield	1099,64	1014,25	963,07
Bush	1266,08	1099,09	1091,76
River	26,98	26,98	26,98

b. Change of Settlement Area

From the results of data processing, it shows that there has been a change in settlements in Solok City from the three years that have been identified and the area calculated using calculate geometry, it is obtained that the use of residential land varies every year from 2010, 2015 and 2020.

Table 2. Area of Settlement in 2010, 2015, 2020

Year	Large (Ha)
2010	459,16
2015	665,47
2020	812,96

After finding the results of the area changes in the three years, an overlay between the shapefiles using the previous land use shapefile was found so that the changes in land use turned out to be useful and can be seen in the table below:

Table 3. Settlement Land Use Change from 2010 to 2015

Land Use 2010	Land Use 2015	Area of Change
Ricefield	Permukiman	70,50
Openfield	Permukiman	24,98
Bush	Permukiman	40,53
Mixed Garden	Permukiman	65,3
Total		206,31

Table 4. Settlement Land Use Change from 2015 to 2020

Penggunaan Lahan 2010	Penggunaan Lahan 2015	Area of Change
Ricefield	Permukiman	50,02
Openfield	Permukiman	7,55
Bush	Permukiman	14,75
Mixed Garden	Permukiman	75,17
Total		147,49

2) Compatibility of Settlement in 2020 with Settlement Space Patterns 2012-2031

The following is a map of the suitability of Settlement in Solok City in 2020 with the Spatial Pattern (RTRW) calling for the years 2012-2031:

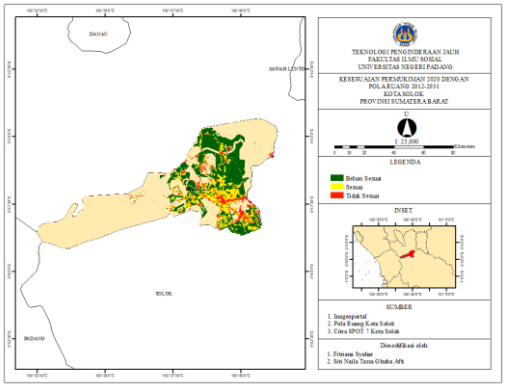

Figure 5. Settlement Suitability Based on Solok City Spatial Pattern

The following are the results of the calculation of the area of the suitability of the settlement with the spatial pattern plan:

Table 5. Suitability of Settlement 2020 with Pattern of Settlement Space

Classification	Large (Ha)	Percentage
Sesuai	506,41	29%
Tidak Sesuai	306,50	17%
Belum Sesuai	957,16	54%

c. Test Accuracy

The accuracy test is carried out from the results of checking samples that have been evenly distributed as shown in the following figure:

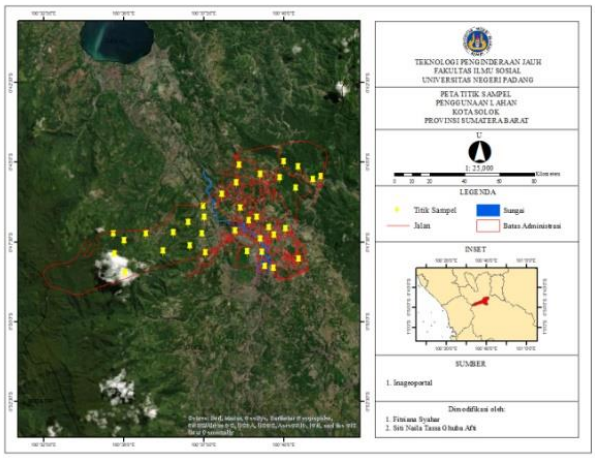

Figure 6. Sample Point Distribution

The results of the accuracy test for the suitability of image interpretation can be seen in the table below:

Table 6. Accuracy Test Matrix

1	2	3	4	5	6	7	Number of samples	Accuracy
7	0	0	0	0	0	0	7	100%
0	6	0	0	1	0	0	7	85%
0	0	1	0	0	0	0	1	100%
0	0	0	5	0	0	0	5	100%
0	2	0	0	7	0	0	9	77%
0	0	0	0	0	6	0	6	100%
0	0	0	0	0	0	1	1	100%
Total Sample and Accuracy							36	91,66%

Description:
1. Forest
2. Check
3. Open Land
4. Settlements
5. Mixed Garden
6. Rice fields
7. River

= Pixel Correct
= Pixel Error

The results of manual classification for mapping changes in settlement area in Solok City using SPOT images with high-resolution image categories are very helpful in identifying objects in the image because the shape of the object is clearly visible, overall all objects in the SPOT image are clearly visible so that when performing the classification of settlements and other land uses manually objects looks clear and good (Magdalena et al., 2021). The elements of the interpretation of the settlement objects appear to be in a regular pattern in the form of boxes, with bright colors and a fairly rough texture associated with the road. Based on the interpretation results, it was found that changes in settlements have increased every year, from 2010 to 2015 the settlement area increased by 206.31 Ha with a settlement area of 459.16 Ha in 2010 and 665.47 Ha in 2015, then from 2015 until 2020, the area of settlements will continue to increase by 147.49 hectares with a residential area of 812.96 hectares in 2020. During the last 10 years, the area of settlements in Solok City has changed to an area of 353.8 hectares.

The area of settlements is overlaid with the pattern of settlement space to see the suitability and success of the spatial pattern which is classified into 3 classes of suitability, namely according to the area of 506.41 Ha, not according to the area of 957.16 Ha and the classification not in accordance with the pattern of settlement space of 306, 50 ha. In the study (Siska, 2016) said that the development of settlements that occurred in Solok City slowly changed agricultural areas into residential areas that were not in accordance with the spatial pattern, the reduced area of rice fields in Solok City had an impact on the decline in rice production in Solok City, it In line with the results of this study, the use of paddy fields in the last 10 years experienced a reduction in land area of 136.57 Ha and 125.52 Ha from the reduction turned into settlements, rapid population growth and increasing land requirements often resulted in conflicts in the interests of land use. and the occurrence of discrepancies between land use and the designation plan (Noeraga, Yudana and Rahayu, 2020).

4. Conclusions

Based on the results of the analysis that has been carried out in this study, the following conclusions can be drawn:

1. The use of residential land in Solok City from year to year continues to experience significant changes in area, precisely in 2010 to 2020. The change in the area of the settlement in 2010-2015 increased by 206.31 Ha, then in 2015-2020 the area increased by 147 ,49 Ha. Thus, it is stated that the total change in settlement area from 2000 to 2020 will increase by 353.8 hectares.
2. The suitability of settlements with the plan of settlement space patterns is dominated by the classification level that is not in accordance with the area of 957.16 Ha, then the classification is according to the area of 506.41 Ha and the classification does not match the area of 306.50 Ha.

5. Reference

Arafat, R., Yunaf, A. S. and Marliantoni, M. (2021). Analisis Perubahan Penggunaan Lahan Dan Kerapatan Vegetasi Di Kawasan Pertambangan Rantau Pandan Kabupaten Bungo," Jurnal Mine Magazine. Available at: https://ojs.umb-bungo.ac.id/index.php/MineMag/article/view/681.

Adenan Yandra Nofrizal (2018). Identifikasi Perubahan Penggunaan Lahan di Kota Solok, Sumatera Barat Berbasis Penginderaan Jauh dan SIG dengan menggunakan Object Base Image Analyst (OBIA). Seminar Nasional Geotik .

Arafat, R., Yunaf, A. S. and Marliantoni, M. (2021). Analisis Perubahan Penggunaan Lahan Dan Kerapatan Vegetasi Di Kawasan Pertambangan Rantau Pandan Kabupaten Bungo," Jurnal Mine Magazine. Available at: https://ojs.umb-bungo.ac.id/index.php/MineMag/article/view/681.

Adenan Yandra Nofrizal (2018). Identifikasi Perubahan Penggunaan Lahan di Kota Solok, Sumatera Barat Berbasis Penginderaan Jauh dan SIG dengan menggunakan Object Base Image Analyst (OBIA). Seminar Nasional Geotik.

Ahmad Pratama, Putra (2011). Penataan Ruang Berbasis Mitigasi Bencana Kabupaten Kepulauan Mentawai. Jurnal Penanggulangan Bencana Volume 2 Nomor 1, Tahun 2010.

Fauzi Iskandar, M. Awaluddin, Bambang Darmo Yuwono. (2016). Analisis Kesesuaian Penggunaan Lahan Terhadap Rencana Tata Ruang/Wilayah Di Kecamatan Kutoarjo Menggunakan Sistem Informasi Geografis. Program Studi Teknik Geodesi Fakultas Teknik Universitas Diponegoro

Fitzpatrick-Lins, K. (1981) "Comparison of sampling procedures and data analysis for a land-use and land-cover map," Photogrammetric Engineering and Remote Sensing. asprs.org. Available at: https://www.asprs.org/wp-content/uploads/pers/1981journal/mar/1981_mar_343-351.pdf.

Iwan Kurniawan, et al. (2011). Pemodelan Spasial Perubahan Penggunaan Lahan di Taman Nasional Gunung Halimun Salak dan Daerah Penyangganya. Journal of Regional and Rural Development Planning, Vol. 1 (3): 270-286

Maurinus Roy, et al. (2017). Dinamika Perubahan Dan Kebijakan Pemanfaatan Ruang Di Kabupaten Bogor, Provinsi Jawa Barat. Journal Of Env. Engineering & Waste Management, Vol. 2, No. 2.

Magdalena, R. et al. (2021) "Klasifikasi Tutupan Lahan Melalui Citra Satelit SPOT-6 dengan Metode Convolutional Neural Network (CNN)," JEPIN (Jurnal Edukasi …. Available at: https://jurnal.untan.ac.id/index.php/jepin/article/view/48195.

Malingreau, J. P. (1978) "Penggunaan lahan pedesaan penafsiran citra untuk inventarisasi dan analisanya," Yogyakarta: PUSPICS UGM BAKOSURTANAL.

Noeraga, M. A. A., Yudana, G. and Rahayu, P. (2020) "Pengaruh Pertumbuhan Penduduk dan Penggunaan Lahan terhadap Kualitas Air," Desa-Kota: Jurnal …. Available at: https://jurnal.uns.ac.id/jdk/article/view/17058.

Nofita, Siska, Sitorus. (2016). Konversi Lahan Sawah Dan Arahan Pengendaliannya Di Kota Solok. Jurnal IPB. Tahun 2016

Oldenborger, G. A. and Short, N. (2022) "Permafrost thaw sensitivity prediction using surficial geology, topography, and remote-sensing imagery: A data-driven neural network approach," Canadian Journal. doi: 10.1139/cjes-2021-0117.

Ramadina, F. and Ayesha, I. (2019) "Mitigasi Risiko Rantai Pasok Agribisnis Beras Solok Pada Ud. Cahaya Makmur Di Kecamatan Lubuk Sikarah Kota Solok," Unes Journal Mahasiswa Available at: https://faperta.ekasakti.org/index.php/UJMP/article/view/29.

Siti Zahrotunisa, Prama Wicaksono. (2017). Prediksi Spasial Perkembangan Lahan Terbangun Melalui Pemanfaatan Citra Landsat Multitemporal di Kota Bogor. Program Studi Kartografi dan Penginderaan Jauh, Fakultas Geografi UGM, Vol. 2, No. 1.

Purwadhi, Sri Hardiyanti dan Sanjoto, Tjaturahono Budi. (2008). Pengantar Interpretasi Citra Penginderaan Jauh. Lembaga Penerbangan dan Antariksa Nasional dan Universitas Negeri Semarang.