



## UTILIZATION OF SATELLITE IMEGERY FOR MAPPING SETTLEMENT DEVELOPMENT TRENDS IN THE CITY BUKITTINGGI

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**ABSTRACT:** This research was conducted to see the trend of the development of residential areas in the City of Bukittinggi using remote sensing methods. This technique is considered important and effective in providing spatial information on the earth's surface quickly, precisely and easily. This study aims to classify land use for residential areas using Landsat 8 OLI (Operational Land Imager) imagery. In this study, the maximum likelihood classification (MLC) method was used. The research used is descriptive with a quantitative approach, namely using numerical data, analysis, interpretation and presenting data in numerical form for sampling in identifying the results of land use for settlements in the City of Bukittinggi.

The research results have changed in the last 5 years, it was found that there was an increase in residential areas of 7.92 ha in 2016 and 2021 using Landsat imagery. The results of the research in the form of a map are land use maps in the City of Bukittinggi to see the distribution of residential areas.

*Keywords : Land Use, Settlements, Landsat Imagery, MLC, Remote Sensing..*

### 1. INTRODUCTION

Very rapid population growth and increasing community demand for land, often resulted happening a mismatch between land use and its designation (Triagus 2012). The increase in urban population also increases the need for land. Because land cannot be increased, land use changes occur which tend to reduce the proportion of previous lands. As an example of the case of changing the use of agricultural land into non-agricultural land. (Kusrini, 2011) the land is an area on the surface of the earth with certain characteristics which include the biosphere, atmosphere, soil, geological layers, hydrology, population, plants, animals and results of human activities past and present. These characteristics have a significant influence on land use by humans in the present and in the future (Kusrini, 2011).

Due to population growth, the demand for built-up land is increasing for settlements because there are many reasons that encourage people and companies to settle in a city, including the city of Bukittinggi. On the one hand, cities embody advantages that make life more comfortable, such as proximity to other people, jobs, recreational and shopping facilities or institutions needed to live in a modern economy. (Hitzschke, 2011) there is a strong influence showing that too many residents in a certain area generate negative externalities for the costs due to urbanization for example pollution, energy-intensive use, noise caused for example by traffic, and high urban rents, so it becomes a long and time-consuming arduous task on an ongoing basis. Settlements are one of the basic human needs that must be met so that humans can live prosperously and in accordance with human dignity. Apart from being an individual human being, he is also a social being. Humans do not live alone but live together and form groups that are spread in one area, equipped with the facilities and infrastructure needed by humans or known as settlements. In general, the meaning of human settlements is all artificial and natural formations with all their equipment, which are used by humans both individually and in groups in order to organize a decent life (Yunus, 1987).

Article 28H Paragraph 1 of the 1945 Constitution states that housing is one of the basic rights of the people and every citizen has the right to live and have a good and healthy environment. In terms of development in all fields and in particular the construction of housing and settlements, the community plays the main role, while the government has an obligation as the party tasked with directing, guiding, and creating a conducive atmosphere for national and regional development. Settlements that are used as residences are an urgent need and cause society to occupy land and build settlements independently in areas designated and not designated for independent settlements without paying attention to aspects environment with all existing limitations (Bintarto 1987).

The residence is an important aspect of life because it is one of the primary human needs. As time goes by, the need for land for housing is getting higher, this is influenced by population growth, which continues to increase



every year, including in the City of Bukittinggi. The city of Bukittinggi one of the cities after Padang in West Sumatra has a fairly rapid urban development that has had an impact on the surrounding area. In these areas requiring land for the availability of settlement development, the tendency of the trend of settlement development is towards suburban areas as one result of the expansion of urban activities. Most cities can no longer accommodate the increasing population base so population growth is spreading toward the suburbs (suburban). One of the impacts is the increasing number of residents.

Population in Bukittinggi which drives the increasing need for housing. This is what makes the builders aggressively build housing in the sub-districts of Aur Birugo Tigo Baleh, Guguk Panjang, and Mandiangin Koto Selatan, which continue to increase every year. Meanwhile, physically, the City of Bukittinggi is surrounded by areas with quite steep slopes, namely the presence of Sianok Gorge and Mount Singgalang, and Mount Merapi, which causes the carrying capacity of the city's land to be limited. The slope characteristics of the city of Bukittinggi, where parts of the area are hills and valleys (reaching 25% of the city area) are also another reason for the limited carrying capacity of development.

The city of Bukittinggi in urban areas with a complexity that will keep going developing from time to time and covering the field of development, this development will be a special attraction for people from other regions to carry out economic activities such as plantation crops which are marketed in the city of Bukittinggi. In addition to education and Central government, also influencing developments in the city of Bukittinggi and tourist attractions also affect developments in the city of Bukittinggi. This has an impact on migration that occurs due to increased activity both in terms of space and increased activity. Behind the city of Bukittinggi which is used as a tourist city, also has environmental problems where the problems that occur are caused by garbage problems, limited parking space, street vendors, buskers or street children, pre-schoolers trade or tourism, prolonged traffic jams, and the potential for slum settlements that occur in the city of Bukittinggi due to the large number of migrants visiting and settling down. Bukittinggi has a de jure area of 25.24 km<sup>2</sup> based on government regulation No. 84 of 1999 concerning changes to the boundaries of the City of Bukittinggi. The administrative area of Bukittinggi City is divided into 3(three) districts and includes 24 sub-district where Guguk Panjang District with an area of 6,831 Km<sup>2</sup> (683.10 ha), Mandiangin Koto Selatan District with an area of 12,125 Km<sup>2</sup> (1,215.60 ha) and Aur Birugo Tigo Baleh District with an area of 6,252 Km<sup>2</sup> (625.20 ha). based on statistics center data city Bukittinggi seen an increase in the number many residents 119,183soul(per month March 2018).

(Bukittinggi city government, West Sumatra province), whereas in 2019 there was an increase in the population of 130,773 people (BPS Bukittinggi), in 2021 there was a population of 121,028 people (BPS Bukittinggi). With the basis of population data collection, the availability of good settlements and urban infrastructure can be prepared so that it does not bring new problems due to an increase in the number of residents. The people of the city of Bukittinggi have different levels of socio-economic status, spread over three sub-districts, namely Guguk Panjang, Mandiangin Koto Selatan, and Aur Birugo Tigo Baleh sub-districts. Good socio-economic conditions in the community will support good levels of community participation. According to Pasaribu and Simanjuntak (1986, p.349), the forms of participation are divided into five, namely participation of property, energy, skills, ideas, and social participation.

The settlement trend here relates to the existence of support for the availability or interest of the area that is used as a trend. Judging from several factors, the Bukittinggi area is a center of government, trade center, and education center and there are also tourist attractions that make Bukittinggi a tourist spot and contribute to providing a place to live for migrants who want to settle down or live. The availability of agricultural land and vacant land on average has changed its function into settlements from non-settlements previously due to movements every year to convert into built-up land such as settlements and until now there has been a surge in the need for housing in Bukittinggi due to there is an increase in population every year continues to rise and resulting in investors who are ready to cultivate-settlement land settlements because it is caused by the pressing need for a place to live. There is a relation to the title Utilization of Satellite Imagery frontend Mapping Settlement.

Development in the CityBukittinggi by using the role of remote sensing for monitoring this phenomenon is a roleDeep Sensing development of residential areas to predict population data, estimation of flood-prone areas through remote sensing imagery is carried out by identifying the causative factors disaster (flood), detect land use can be done more carefully. Where is the remote sensing image using resolution spatial and high temporal resolution is very appropriate for regional studies settlements that are experiencing rapid settlement development. This study aims to map the trend of settlement development in the city of Bukittinggi with Landsat



imagery and to map the suitability of the trend of settlement development that is overlaid with the RTRW of the city of Bukittinggi.

## 2. THE METHOD

Research using this descriptive approach has the aim of describing the object of research or research results. Quantitative research uses numerical data investigation methods, which emphasize organization, analysis, interpretation, and presenting data in numerical form (Judithe, 2018). In this study, data were obtained from the results of the interpretation of Landsat imagery using the Maximum Likelihood method which produced land use data after that made observations in the field to see and take pictures to serve as documentation.

### a. Data collection technique

In the data collection technique stage, the type of data used in this study is in the form of secondary data. The secondary data that was processed in the research were the Regional Administrative Boundary Map, the 2010-2030 City Spatial Planning Map of Bukittinggi, and Landsat Imagery obtained from the USGS.

### b. Data pre-processing techniques

Before entering the data processing, the first steps are as follows:

#### a) Radiometric

Correctionaim For fix the pixel value to match the one should normally considering factors. Atmospheric disturbances are the main source of error, atmospheric effects cause the reflection value of objects on the earth's surface which is recorded by the sensor and does not become the original value but becomes larger due to scattering due to the absorption process from the scattering.

#### b) Pansherpening

As a sharpening method using two data. an example of an explanation is that the higher resolution panchromatic data (raster band) is combined with the lower resolution of the multiband raster data. To create color high-resolution datasets that can enhance image quality

#### c) Image Cropping

Is a stage that done after step previously Step cuts are made based on limitadministration. Bukittinggi obtained from the Public Works Office of the City of Bukittinggi.

### c. Processing stage

Image classification is carried out using the Supervised method (Guided Classification) is a classification that uses trace areas, so we determine what objects are in the image to make polygons of a certain area (signature file), then the application will look for areas that have similarities based on the existing signature file (already we do). Here the researcher uses Maximum Likelihood Tools for data processing. Where is the Maximum Likelihood is a classification that performs parameter classification by assuming a normal or nearly normal spectral distribution for each characteristic of interest. The same probability between classes is also assumed. MLC also requires representative spectral training sample data for each class accurately with estimate values of the vectors and covariance matrices required by the classification algorithm. When the training sample is limited or unrepresentative, inaccurate element estimation often results in poor classification (Dongsheng Lu et al, 2003).

### d. Accuracy test

Accuracy test assessment can be carried out to obtain information on the level of accuracy a classification result. In this study, the method used to determine the level of accuracy of land use using the kappa index method. The Kappa index is a method that can be used to calculate the overall accuracy value which is obtained by dividing the total number of observation samples so that it can show the correctness of the classification results and the accuracy with the kappa index (kappa accuracy) which shows the consistency of the accuracy of the classification results. calculation (Lillesand and Kiefer in Indriyanto et.al., 2019).

The kappa formula used is as follows:



$$\text{Kappa Accuracy} = [(\sum_{i=1}^r X_{ii} - \sum_{i=1}^r X_i X_i) / (N^2 - \sum_{i=1}^r X_i X_i)] \times 100\% \dots (1)$$

$$\text{Users Accuracy} = \frac{K_{ii}}{K_i} \times 100\% \dots (2)$$

$$\text{Producers Accuracy} = \frac{K_{ii}}{K_i} \times 100\% \dots (3)$$

$$\text{Overall Accuracy} = [(\sum_{i=1}^r X_{ii}) / N] \times 100\% \dots (4)$$

Information :

N : Lots of samples

X<sub>i</sub> : Number of samples in row-th

*i*

X<sub>i</sub> : The number of samples in the i-th column

X<sub>ii</sub> : the diagonal value of the contingency matrix of the i-th row and i-column

Where accuracy in classification included in the Overall Accuracy tolerance value of more than 80% is said to be good (shirt in Nawangwulan et.al, 2013), so with Kappa Accuracy worth 0.81-1.00 then the results of the category are high (Landis and Koch, in Ra,adhan et al, 2016).

### e. Data analysis technique

Researchers used land use classification analysis techniques for settlements and overlays using Arcgist software the overlay is done to see the results of the land use classification that is overlaid with the city spatial and regional layout plan (RTRW). Bukittinggi to find out the Development of Settlement Trends.

Researchers used the Supervised method for the Classification of Land Use for Settlements with a working system of the supervised method to determine training areas (sample areas) on certain land class images, determining knowledge of area analysis in images regarding research areas. Examples of area pixel values are then used by the computer as a key to identify other pixels and areas that have similar pixel values is then categorized into pre-existing land classes. After performing the maximum likelihood analysis, the final step is to overlay the results of the maximum likelihood classification with the RTRW to get the final map results. The output that is obtained in the final result is a land use map 2016, the land use map for 2021, and the settlement development map for the City of Bukittinggi overlaid with the RTRW.

## 3. RESULTS AND DISCUSSION

### 3.1 Land Use in 2016 and 2021

Land use can be obtained from the results of remote sensing analysis using Landsat satellite imagery using the 432 band composite, namely natural color after atmospheric correction, where before digitizing we can find out the object in the image from the hue and color to ensure body water, settlements, open land, shrubs, and forests with the help of Google Earth using time series.

On the 2016 and 2021 scale 1 land use maps: 50,000, - the results of the interpretation of Landsat 8 imagery with Path 127 row 60 which has a spatial resolution of 30 meters sourced from the USGS Earth Explorer, there are five classes of land use in the City of Bukittinggi namely Water Bodies, Settlements, Forests, Open Land, and shrubs. Identification of land use area using the Supervised Maximum Likelihood method can be seen as follows:

Table. Land Use the City of Bukittinggi in 2016 Source: Results of Interpretation of City of Bukittinggi in 2016.

No	Land Use Class	COUNT	Area (Ha)
Water body	3609	324.81	3609
Settlement	10162	914.58	10162
Shrubs	6017	541.53	6017
Forest	5905	531.45	5905
Open field	2353	211.77	2353
Total			2524.14



Classification Results of Land use in 2016 after the Maximum Likelihood classification was carried out, there were 5 classes settlements are more dominant with an area of 914.58 ha and the least is open land with an area of 211.77 ha.

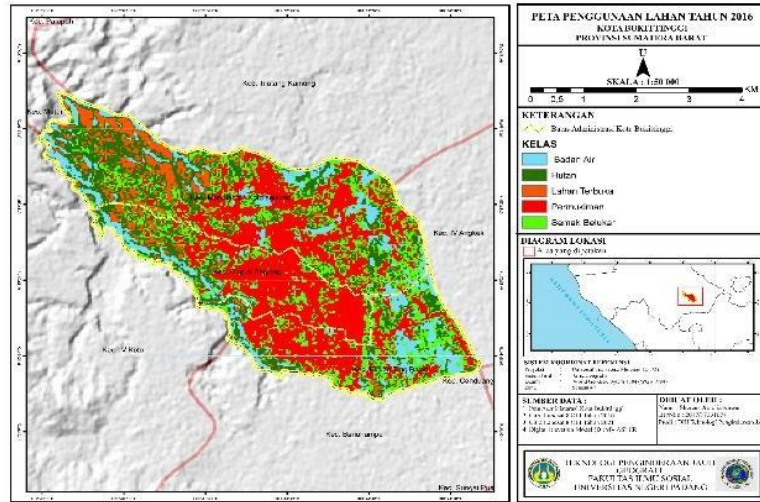


Figure 6. 2016 City of Bukittinggi Land Use Map

The latest 2021 land use table and several land use classes that will be widely seen are as follows:

Table 2 of Land Use for the City of Bukittinggi in 2021.

No	Land Use Class	COUNT	Area (Ha)
Water body	2985	268.65	2985
Settlement	10250	922.50	10250
Shrubs	6488	583.92	6488
Forest	7395	665.55	7395
Open field	928	83.52	928
<b>Total</b>			<b>2524.14</b>

Land use classification results In 2021, which has been processed using the maximum likelihood classification, the more dominant class is settlements with an area of 922.50 ha and the least is open land with an area of 83.52 ha.

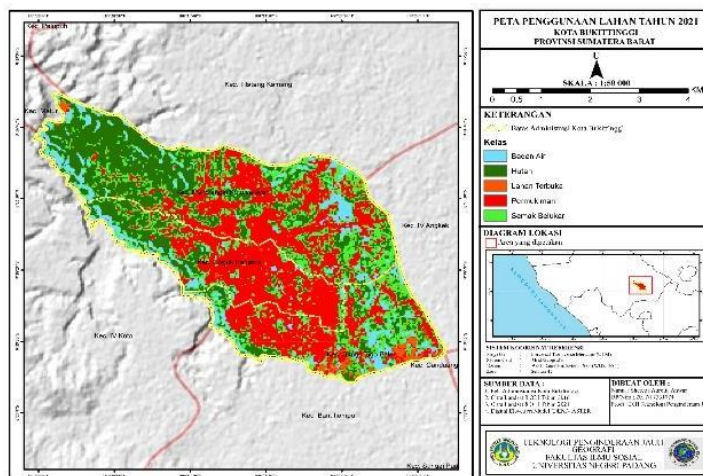


Figure 7. Land Use Map for the City of Bukittinggi in 2021



### 4. Accuracy Test

Accuracy test is the final process stage in clarification, this process is very important to do, in the remote sensing data processing stage. An accuracy test is very useful and helps to see whether or not the resulting classification results are appropriate study. The method used in the accuracy test phase is the kappa index method. The distribution of sample points with a total of 40 sample points is based on observations of Google Earth images as a benchmark for spaciousness.

Based on observations made from 40 points spread across locations in the classification, there are points that are the same as the results of real observations using Google Earth and there are also points that are different from the results of observations. This error occurs because the type of land use is classified as color and hue which is similar to the other classes. True and false from the random sample distribution are then entered into the kappa index table which is useful for facilitating the process of calculating the accuracy value of a process classification. The following table is a presentation of Kappa index data

Classification errors that occur in the classification results are because the class has hues and colors that are almost the same as the hues and colors of other classes. From the table above it can be seen that the class of land use. There are 5 sample points correctly classified as water bodies and 1 point classified as forest. For the forest class, there are 15 sample points classified correctly and 3 points classified as shrubs. There are 3 sample points in open land correctly classified and 1 classified point to settlement. Settlements exist 15 sample points are classified correctly, and for shrubs, there are 2 points classified correctly.

The accuracy of the overall results of image classification using the supervised classification method is 87.5%, this value is more than the minimum limit that has been set as an accuracy requirement. The research level of accuracy used must not be less than 82.83%.

### 5. Final Merger Results

Landsat imagery with RTRW Space utilization after visual digitization is carried out and overlaid with the experienced RTRW expansion of 7.92ha and causing a phenomenon development of space utilization, especially in developing settlements in the city of Bukittinggi. Based on the research that has been done before, it is obtained fact of value change space utilization otherwise if it is negative then utilization the space experiences decrease in the area (Sharif, 2018).

The final results of land use change data processing in 2016 and 2021 show an increase in settlements every year in residential areas in the City of Bukittinggi using Landsat imagery with the following picture:

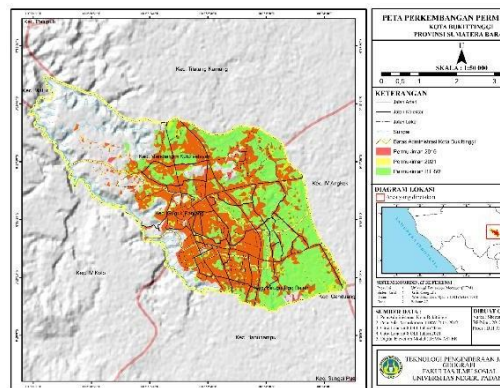


Figure 8. Settlement Development Map in the City of Bukittinggi Year 2016-2021 in Overlay with RTRW

To get the final result of land use correction per year and overlaid with the RTRW There will be an increase in 2016 and 2021 with the area of settlement development 7.92 ha. Where there has been a significant change in the last 5 years. The following is a table of changes in land use development settlements in the City Bukittinggi uses Landsat Imagery as follows:

### 6. DISCUSSION

Based on the results of processing digital imagery using the supervised Maximum Likelihood classification method for 2016 – 2021 which has a spatial resolution of 30 meters, is overlaid to see the trend of settlement developed over the past five years with the RTRW map of Bukittinggi City, so that five classes of settlement development in Bukittinggi City are obtained, including namely: Water Bodies, Settlements, Open Land, Shrubs



and Forests. In the process of interpreting objects, we need to understand the elements of image interpretation namely: hue or color, shape, size, pattern, texture, shadow, site, and association was seen in the appearance of objects in the image.

For objects that are clearly visible on the Landsat imagery are settlements, where the appearance of the object image is evenly distributed, spread out, and in groups so that the process of identifying settlement objects is easier to determine. Forests are also easier to identify due to the appearance of objects that are dense and far from the center of the city/settlement. Meanwhile, the object of mixed gardens or shrubs is difficult to identify due to a weakness in the 30-meter resolution Landsat image where the objects or positions of the two land use classes do not look much different from the Landsat imagery.

Land use in 2016 results of the classification that has been tested for accuracy in as many as 40 samples by calculating the kappa index obtained an accuracy level of 87%. The results of this interpretation can be said to be accurate and can be used for the next stage.

## 7. CONCLUSION

The conclusions obtained are based on the formulation of the problem that has been described previously, while the results that can be drawn are as follows:

1. In the development trend of settlements in Bukittinggi there are changes in land use every year experience change due to the need for open land that will be used as built-up land is increasing for needs where settlement patterns in the City of Bukittinggi are spread out (Radial). Densely populated settlements can be seen in terms of development and the area that has changed, in Mandiangin Koto Selayan District, there is a density of high settlements with scattered patterns, Guguak Panjang settlement density has a spread settlement pattern and Aur Birugo tigo Baleh has a population density low with pattern settlements spread
2. In the trend of settlement development in the City of Bukittinggi, there are areas that are experiencing more dominant changes, namely in the Mandiangin Koto Selatan District with the direction of development to the west.

## 8. SUGGESTION

The suggestions that the researcher wants to convey are as follows:

1. For further research it is recommended to use a map that has a high resolution so that the results are accurate And get more accurate and maximum from previous research.
2. The need for re-examination for further research, where before conducting research about development and settlements should be studied in the form of literature to identify studies' eligibility or comfort to avoid the risk of natural disasters.

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