Mapping the Suitability of Land Use to the Regional Spatial Plans in Batam City

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Abstract. Land use is a tangible manifestation of the impact of human activities on the earth's surface. If the population increases and activity increases, a region's land use patterns may change. Batam city is one of the cities that attract immigrants and has the potential for rapid growth and development. In the arrangement of land use that is not appropriate, it will urge natural space to change function, so that a regional spatial plan is needed that is regulated by laws and regulations related to the Regional Spatial Plan / Spatial Pattern obtained from BP Batam. This study aims to map land use and determine the suitability of land use that occurs in Batam City in 2021 based on interpretation of Landsat-8 satellite imagery in 2021 by digitization on-screen and overlay. The method used in this study used the Multispectral Maximum Likelihood classification method. The Results of this study provide information in the form of land cover maps, land use maps with classifications totaling 12 classes in accordance with the class III classification set by Malingreau consisting of airports, lakes, forests, industries, ponds, open land, sea, mangroves, ports, plantations, settlements and land use suitability maps with appropriate area of 76608.97 Ha and area not in accordance with 25560.74 Ha to spatial plan Batam City Area.

Keywords: Land Use, Spatial Planning, Multispectral Maximum Likelihood Classification.

1 Introduction

Land use is a tangible manifestation of the impact of human activities on the earth's surface. If the population increases and activity increases then the land use pattern of an area will change. In improper land use arrangement, it will urge the transition of natural space to change functions, so that land use planning needs to be adjusted to the Spatial Plan [1].

Batam city is located in Riau Islands Province is the city with the fastest development potential in Indonesia. With a type of ground surface that can be classified as flat hilly variations with a height of 160m. A lot of land in Batam has been built residential areas, economic areas that could be the land is not in accordance with the Spatial Plan. Rapid development can change

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some areas in batam used to develop business in the field of industry and tourism that can attract migrants and cause an increase in the population [2]. The population of Batam has increased to reach 1,107,551 in 2019[3].

In his study, explaining the factors that affect the deviation of land use of an area is the density of the population, the area of agricultural land, buildings dibantaran river and distance to the city center. Socioeconomic factors such as education, income work, land ownership as well as the level of public knowledge about spatial plans are low due to the lack of socialization about the Spatial Plan also affects irregularities that occur[4].

Tsai in 2011 have detect changes in an object and calculate the difference temporally. Pixel-based image classification, namely the post-classification method was carried out in this research. The post-classification method is a commonly used method by classifying each of these temporal satellite images to identify changes in land cover and use[5].

Dewi in 2013 have identified of the building object changes in 2002 to 2012 is conducted by utilizing digital map data 2002 and WorldView-2 imagery using supervised classification method based on maximum likelihood (maximum similarity) to identify building objects changes in the UP Rungkut the year 2002 to 2012[6].

This study aims to examine the land use that occurs in Batam based on the interpretation of Landsat-8 satellite imagery for mapping and see the extent of the existence of the land. Land use data is obtained from the classification of satellite imagery. Spatial land modeling. The results of this study will provide information in the form of land use maps in the city of Batam, and maps of Land Use Conformity to the Spatial Plan of Batam City.

2 Research Method

2.1 Location and Time of Research

This research was conducted in Batam City located in Riau Islands Province. Batam city has 12 subdistricts consisting of Batam Island, Rempang Island, Galang Island, and other scattered small islands. Batam city is at coordinates 0º25'29" - 1 º 15'00" LU, 103 º 34'55" - 104 º 26'04" BT.

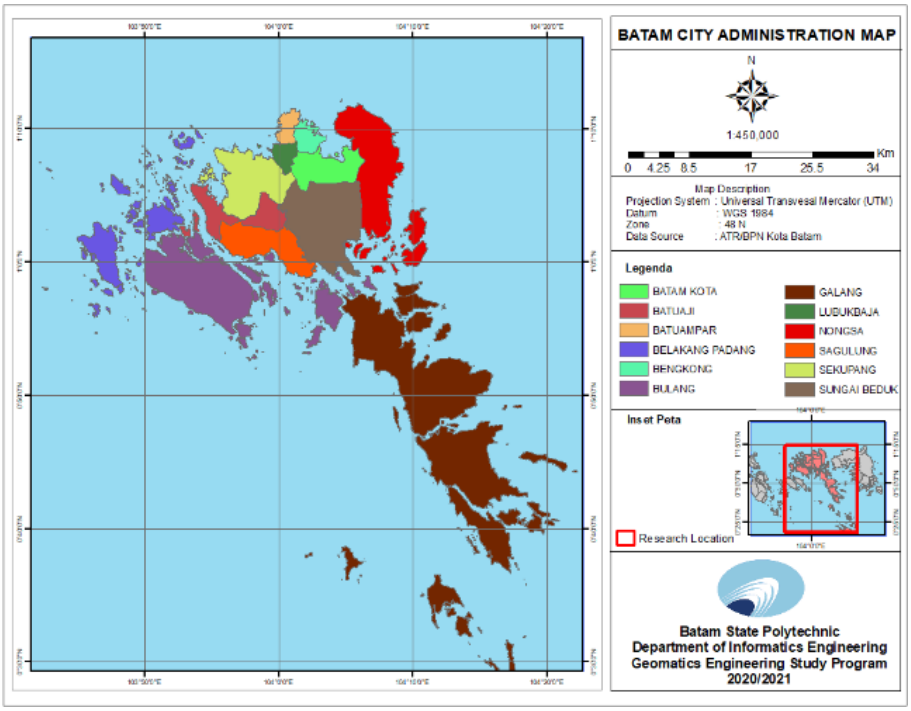

Fig. 1. Architecture of a typical wireless sensor node

2.2 Tools and Materials

In this reesearch of course supported with some hardware and software for data collection and processing activities. The following tools are used in this study :

1. Hardware : Laptop, GPS Handheld, Camera
2. Software : Microsoft Word 2019, Arcmap 10.3, and Envi 4.6

2.3 Data Collection Technique

In this study the method used is Literature Studies. The process of collecting theoretical reference data that suits your needs. The references collected contain about:

1. Spatial Data consisting of Batam City Administration Map, Spatial Plan Map of Batam City Area in 2018.
2. Non-Spatial Data consists of Landsat Satellite Imagery 8 Year 2021.

2.4 Data Processing Technique

map of land use conformity and land cover in the form of shp in overlay then into a work map so that field validation is carried out.

Data transmitted from satellite to earth will experience geometric and radimetric distortion. This shows that the energy level of the object, the location of the object on the map and the geometric appearance of the object in the image have digital values influenced by the atmosphere. Image correction serves to overcome and reduce existing distortions so that it will create more accurate image data[7].

The result of the geometric correction is the RMSE (Root Mean Square Error) value, where for the geometric accuracy test, the average RMS error value of the image must be less than or equal to 1 (one) pixel[8].

Radiometric correction is an improvement due to radiometric defects or errors, namely errors in the optical system, errors due to interference with electromagnetic radiation energy in the atmosphere, and errors due to the influence of the sun's elevation angle[9].

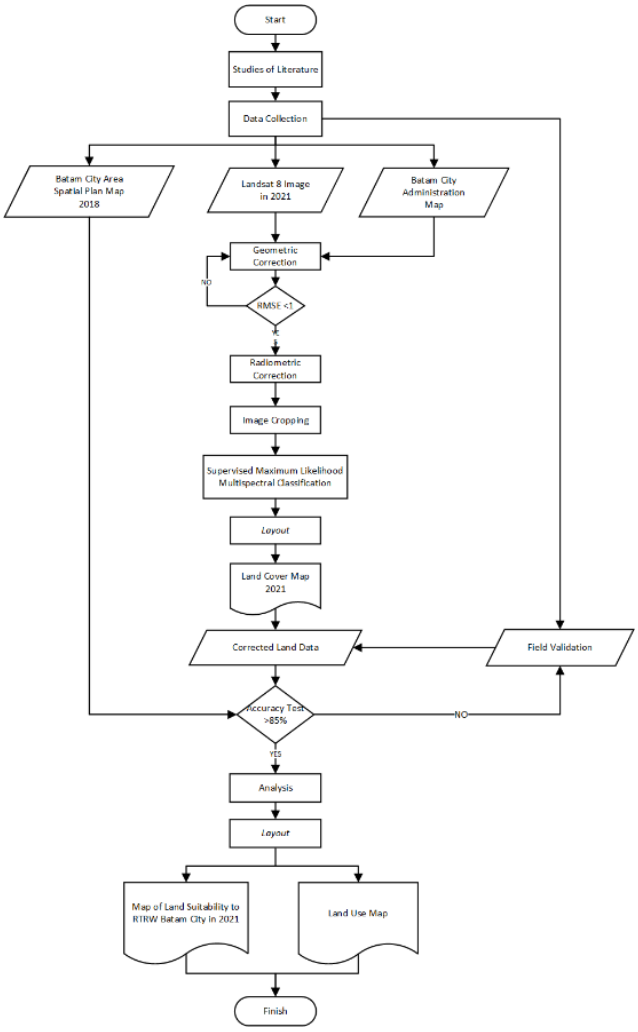

Fig. 2. Research Flow Chart

2.4.1 Land Use Classification

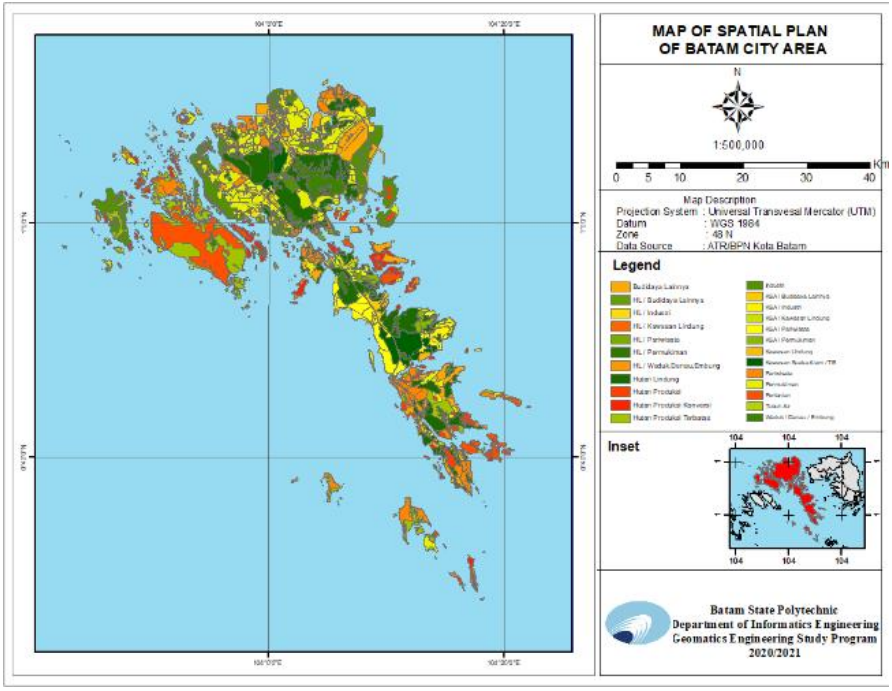

Fig. 3. Spatial Map of Batam City

According to Malingreau (1979), Land use classification is a reference in the interpretation process if land use mapping data uses remote sensing imagery. The purpose of classification is to make information data simple and easy to understand. Grouping objects into classes based on equations in their nature, or associations between objects is called classification[10].

2.4.2 Maximum Multispectral Classification

Classification is done by Supervised Classification method. The method considers the spectral similarity to the maximum spectral dominant object. Objects will be inserted into one class if spectral is far from maximum into another class.

Supervised classification is done by selecting the training area for each land cover category that must be separated in the classification and using the spectral characteristics of each area to classify the image. The concept of presenting data in numerical form, graphs, or diagrams [11].

2.4.3 Slovin

The analysis technique in this study uses accuracy test on classification results. Sampling in the field is done to test the level of thoroughness of the method used. In this study sampling

techniques were used with the Purpose Random Sampling method. Determination of the number of samples is determined by slovin formula:

$$n = \frac{\mathrm{N}}{1+\mathrm{N}\,e^2} \quad (1)$$

where :

n = number of sample members

N = number of population members

e = fault tolerance limit (note: used 0.05 or 0.1).

2.4.4 Confusion Matrix

Confusion matrix method calculates the amount of user's accuracy obtained by dividing the number of points on the field that is welded correctly, the accuracy of the producer (producer's accuracy) is likely how much reference data in the field is welded correctly, overall accuracy.

Table 1. Confusion Matrix

	Field Data				Total	User
Classification Result Data	Vegetated Area	Non-vegetated Area	Residential Area	Waters		
Vegetated Area	11	1			12	92
Non-vegetated Area	2	5	1		8	63
Residential Area	1	1	19		21	90
Waters				3	3	100
Total	12	7	20	3	44	
Producer	79	17	95	100		

The calculation is :

a. ***Overall Accuracy*** **:** $\left(\frac{(Number\ of\ diagonals\ (yellow))}{number\ of\ entire\ points}\right)\ x\ 100\%$ (2)

b. ***Produser's Accuracy*** **:** $\left(\frac{umber\ of\ dots\ per\ class\ in\ the\ field}{total\ number\ of\ rows\ per\ class\ in\ the\ image}\right) x\ 100\%$ (3)

c. ***User's Accuracy):*** $\left(\frac{Number\ of\ dots\ per\ class\ in\ the\ fieldn}{total\ number\ of\ columns\ per\ class}\right) x\ 100\%$ (4)

3 Result and Discussions

3.1 Image Correction

In the processing of image data in this study the initial stages of geometric and radiometric correction are performed. Geometric correction with the aim of equating the existing coordinates in the image with the actual coordinates.

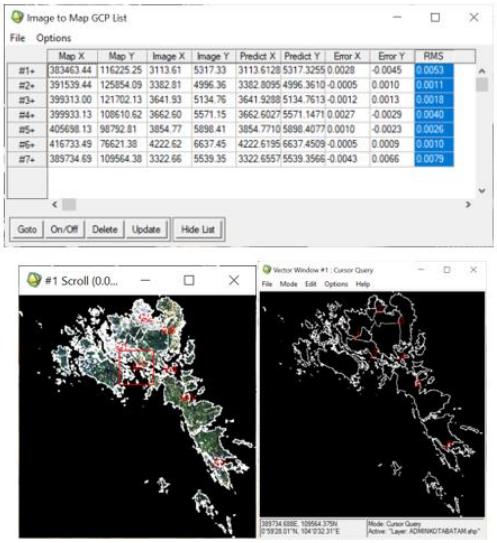

Fig. 4. Geometric Corrections

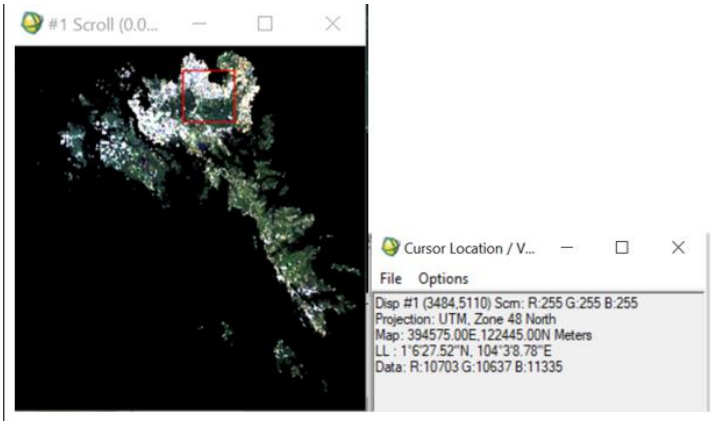

Fig. 5. Radiometric Corrections

3.2 Image Cropping

The Cropping process aims to crop the image to be used and remove unused imagery to make it clearer and more focused. Landsat 8 image in 2018 and 2021 that has been done geometric corrections and radiometric processes then crop the administrative boundaries.

3.3 Multispectral Classification Maximum Likelihood

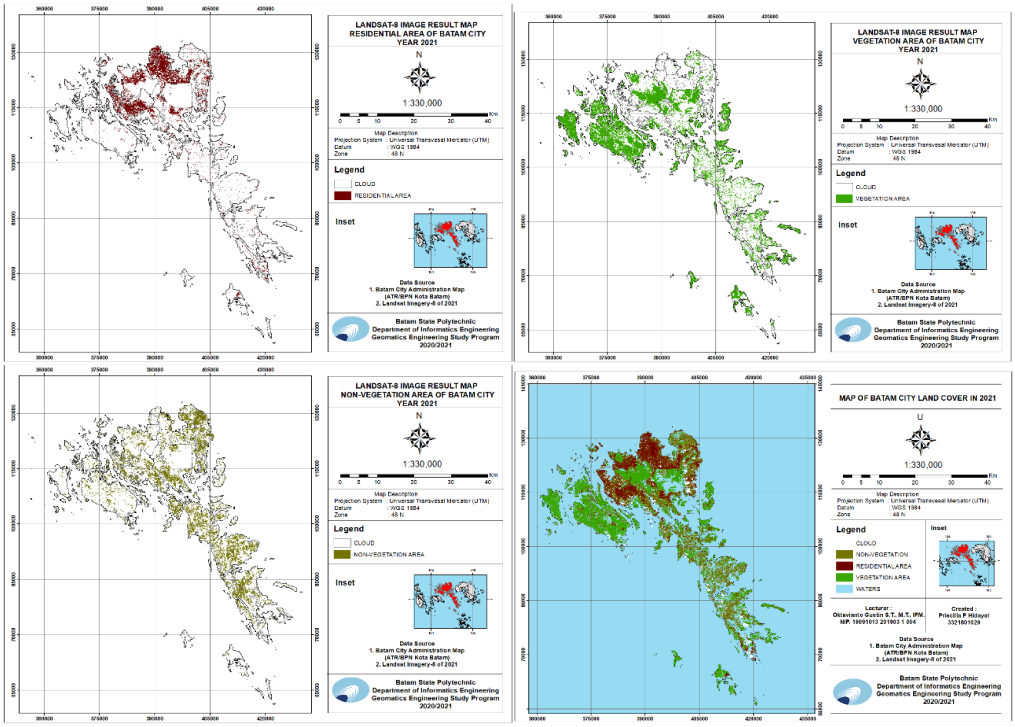

Fig. 6. Maximum Likelihood Classification in 2021

3.4 Accuracy Test

In this study, the accuracy test is carried out using the confusion matrix method which is used to determine the accuracy value of land use. In this study, the variables are satellite image classification data and field validation data. There are 3 stages in the confusion matrix accuracy test, namely overall accuracy (oa), user's accuracy (ua), and producer's accuracy (po).

Table 2. Accuracy Test

	Field Data				Total	User
Classification Result Data	Vegetated Area	Non-vegetated Area	Residential Area	Waters		
Vegetated Area	11	1			12	92
Non-vegetated Area	2	5	1		8	63
Residential Area	1	1	19		21	90
Waters				3	3	100
Total	12	7	20	3	44	
Producer	79	17	95	100		

The calculation is :

1. ***Overall Accuracy*** **:** $\left(\frac{(Number\ of\ diagonals\ (yellow)}{number\ of\ entire\ points}\right)\ x\ 100\%$ = $\left(\frac{38}{44}\right)$x 100% = 0,86 = 86%

2. ***Produser's Accuracy*** **:** $\left(\frac{Number\ of\ dots\ per\ class\ in\ the\ field}{total\ number\ of\ rows\ per\ class\ in\ the\ image}\right) x\ 100\%$

   - Vegetated Area = $\left(\frac{11}{14}\right)$x100% = 79%
   - Non-Vegetated = $\left(\frac{5}{7}\right)$x100% = 71%
   - Residential = $\left(\frac{19}{20}\right)$x100% = 95%
   - Waters = $\left(\frac{3}{3}\right)$x100% = 100%

3. ***User's Accuracy):*** $\left(\frac{Number\ of\ dots\ per\ class\ in\ the\ fieldn}{total\ number\ of\ columns\ per\ class}\right) x\ 100\%$

   - Vegetated Area = $\left(\frac{11}{12}\right)$x100% = 92%
   - Non-Vegetated = $\left(\frac{5}{8}\right)$x100% = 63%
   - Residential = $\left(\frac{19}{21}\right)$x100% = 90%
   - Waters = $\left(\frac{3}{3}\right)$x100% = 100%

4 CONCLUSION

Landsat 8 OLI image classification in Batam City resulted in 4 land cover classes. The land cover classes are vegetated areas, non-vegetated areas, settlements, and waters. The results of the classification accuracy test show a fairly high accuracy and meet the requirements set by USGS (> 85%) namely Overall accuracy of 86%, Producer's accuracy is seen that the water body class has an accuracy value of 100%, residential areas have an accuracy value of 95%, vegetated areas value 79% accuracy, unvegetated area 71% accuracy value. and User's accuracy of water bodies has an accuracy value of 100%, vegetated areas have an accuracy value of 92%, residential areas have an accuracy value of 90%, non-vegetated areas have an accuracy value of 63%.

With the results obtained, it shows that the map resulting from the classification of Landsat 8 images can be used as a material in determining and reviewing regional spatial planning.

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