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The application of Sentinel 2B satellite imagery using Supervised Image Classification of Maximum Likelihood Algorithm in Landcover Updating of The Mamminasata Metropolitan Area, South Sulawesi

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Abstract. Mamminasata Metropolitan Area includes the City of Makassar, some sub-Districts of Maros, Gowa and Takalar Regencies. This metropolitan area were formed based on the Governor of South Sulawesi Province Decree in 2003 with a total area of 246,230 ha. Sentinel-2B is a European optical imaging satellite that was launched on 7 March 2017. It is the second Sentinel-2 satellite launched as part of the European Space Agency's Copernicus Programme, and its orbit phases 180° degrees against Sentinel-2A. The satellite carries a wide swath high-resolution multispectral imager with 13 spectral bands. It provides information for agriculture and forestry, among others allowing for prediction of crop yields. Multispectral classification process can be divided into two types namely supervised and unsupervised classification. In this research, supervised classification was applied which includes a set of algorithms that are based on the entry of sample objects and geographic location. Maximum likelihood algorithm is the statistically most established algorithm. Other algorithm is based on the measurement of the distance between the coordinates of the sample group and the pixel coordinates candidate while the maximum likelihood algorithm using probability calculation. In this algorithm, pixels were classified as specific objects not because of their Euclidean distance, but by the shape, size and orientation of the sample on the feature space. Maximum likelihood algorithm works the following way, program briefly marks each pixel which has a measurement of the pattern or appearance of X into class i whose unit is most likely to be grouped as a vector X. Foundation of the maximum likelihood algorithm uses a probability value of a pixel X to be a member of a particular class or a particular label.

Keywords: Mamminasata, South Sulawesi, Sentinel 2B, Supervised Classification, Maximum likelihood algorithm.

1. Introduction

Mamminasata Metropolitan Area includes the City of Makassar, some sub-Districts of Maros, Gowa and Takalar Regencies. This metropolitan area were formed based on the Governor of South Sulawesi Province Decree in 2003 with a total area of 246,230 ha. The rapid growth in the Mamminasata metropolitan area requires the provision of land cover data of regular bases. Remote sensing



technology is the solution to providing land cover data, providing data on land coverings where satellite image data that can be obtained easily and continuously.

The launch of the Sentinel-2B satellite was a continuation of the constellation program carried out by the Copernicus European Union. Sentinel-2A, was launched in June 2015. Although launched separately, both are placed in the same orbit, which is 180 °. Sentinel-2B is used to monitor pollution, deforestation, weather patterns and changes in Earth's morphology. Sentinel 2B has a view range of around 290 km. Every five days the satellite supplies Earth's image data between 84 degrees North and 84 degrees south which has never been seen before [1].

Maximum likelihood algorithm is based on two principles. First multidimensional space sample class cell is being normally distributed, second this algorithm based on Bayes' theorem decision making. This algorithm considers both the variances and covariances of the class signatures when assigning each cell to one of the classes represented in the signature file [2]. With the assumption that the distribution of a class sample is normal, a class can be characterized by the mean vector and the covariance matrix. Given these two characteristics for each cell value, the statistical probability is computed for each class to determine the membership of the cells to the class [3][4].

2. Study Area

The study area, Mamminasata metropolitan area is located in South Sulawesi Province, Indonesia (Figure 1). Mamminasata consist four region City of Makassar, Sungguminasa (Gowa Region), Takalar Region and Maros Region which has an area of 2.473 Km². this area consists of coastal areas, lowlands and mountains and also consists of various types of land cover: karts, forests, agriculture, urban areas and water bodies



Figure 1. Study area

3. Material and Methodology

3.1. Dataset

This research using sentinel 2B satellite imagery which uses band 2 (blue), band 3 (green), band 4 (Red) and band 8 (Near Infrared). Before doing the land classification using Maximum like hood algorithm all the band dataset, all dataset bands are subjected to atmospheric correction to obtain pixel values without reflectance interference [5]. The atmospheric correction using application from ESA that call ESA SNAP, this application provide only for Sentinel Satellite Imagery correction [6].

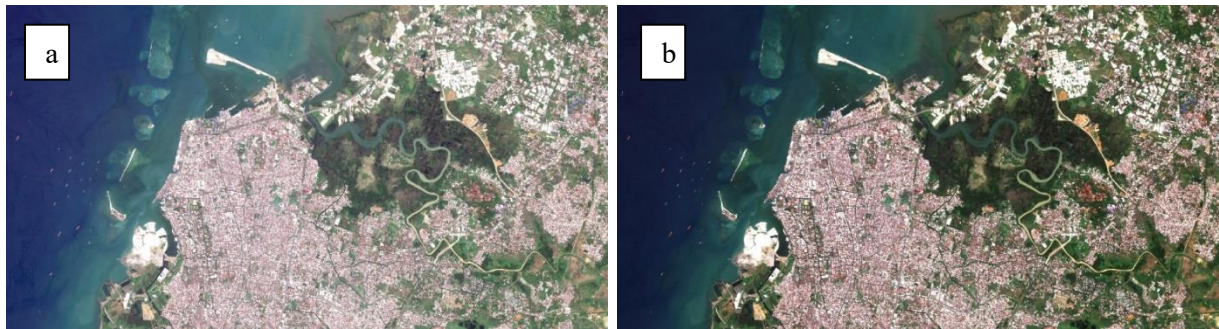


Figure 2. Difference non atmospheric correction image (a) and atmospheric correction image (b)

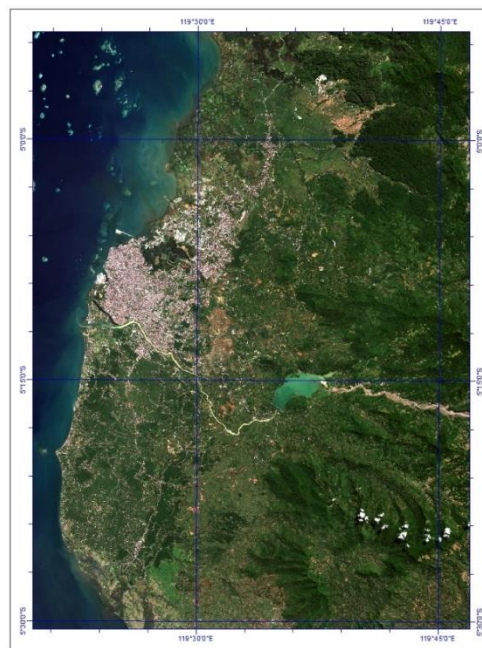


Figure 3. Study area with true colour band combination

Visual analysis is the main method to identify each sample training data. True colour sentinel imagery was used of Makassar World view 2 satellite imagery 2015, Makassar land use map 2006 and from images of google earth. This sample was taken without any land survey or land field verification. False colour Vegetation is used for imagery classification to divide vegetation, urban, and water. The different texture and tone image using for identification Agriculture area, Industrial area, karts and fish pond.

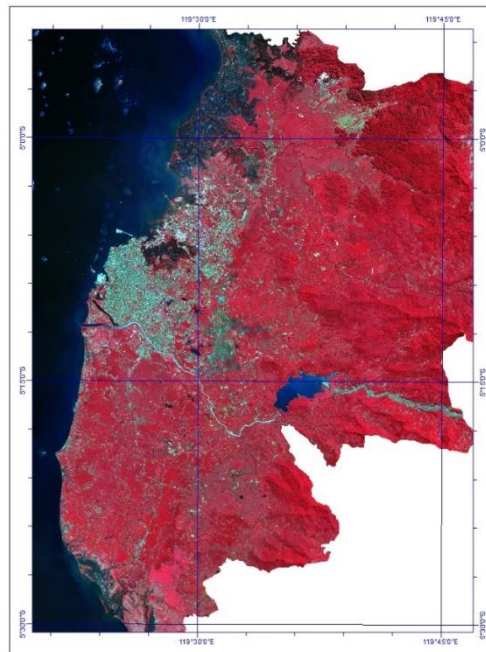


Figure 4. False colour band combination

3.2 Analysis of Maximum likelihood classification

Maximum likelihood classification (MLC) is a method for determining a known class distribution as the maximum for a given statistic [7]. Division of land cover based on pixel data from classification results Karts (2.642.117), Forest (5.624.999), Agriculture (8.992.098), Water (21.464.421), Urban (3.477.220), Fishpond (936.811) and Industrial Area (175.580).

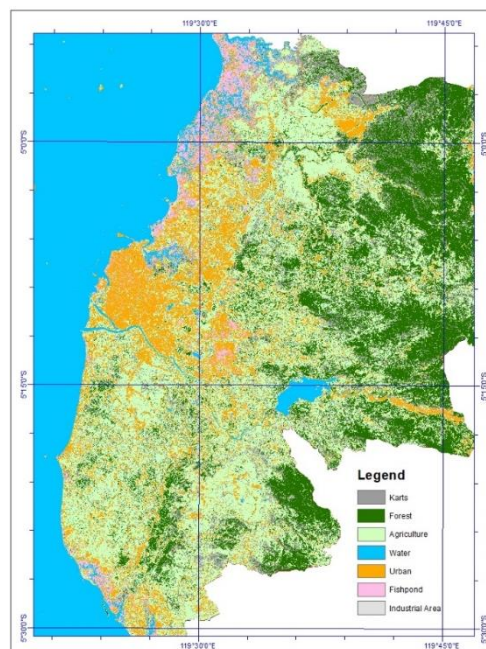


Figure 5. Maximum like hood classification

Most urban area located near of the coastal area while forest or vegetation in mountain and river side. Agriculture area as a dominant land cover especially in outside city of Makassar to see the correlation between each band will be illustrated with the diagram below.

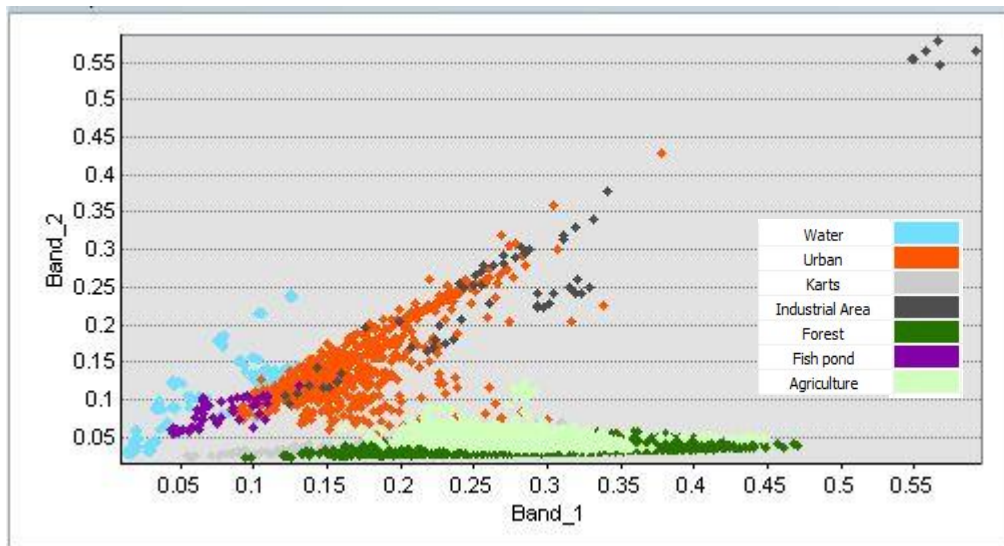


Figure 6. Diagram Correlation between Band 1 to Band 2

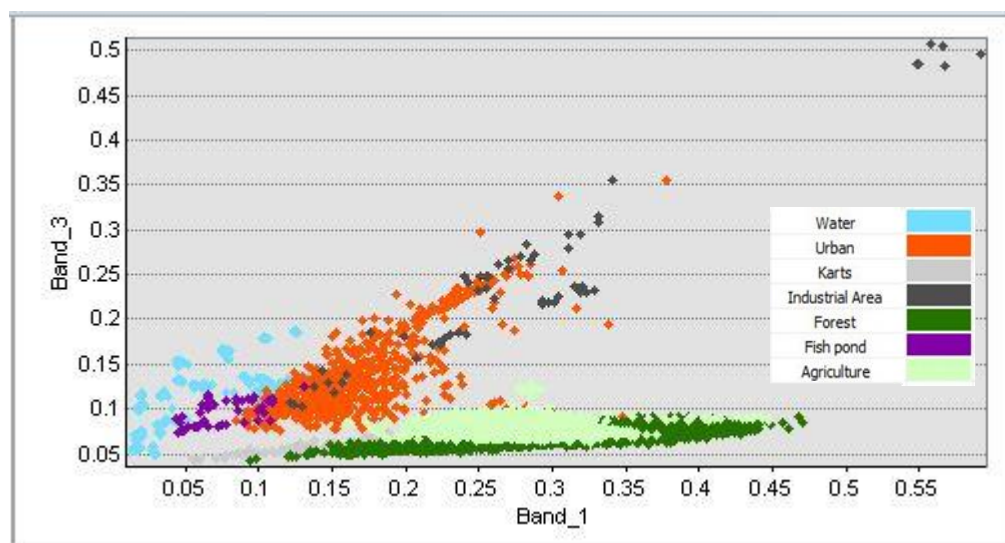


Figure 7. Diagram Correlation between Band 1 to Band 3

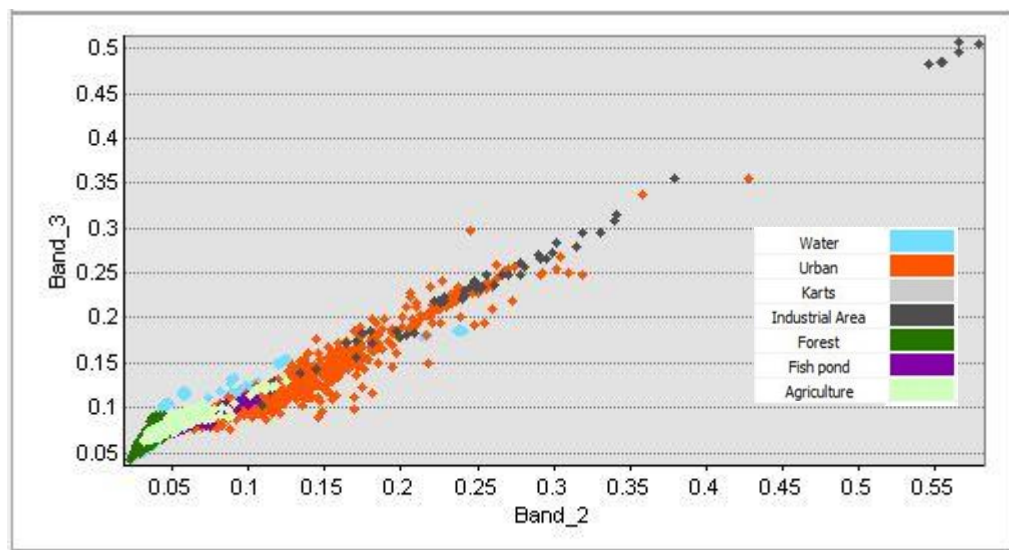


Figure 8. Diagram Correlation between Band 2 to Band 3

4. Assessment accuracy

4.1 Producer Accuracy

Producer accuracy is a measure of the accuracy of a particular classification scheme and shows the percentage of a particular ground class that is correctly classified

$$\text{Producer accuracy} = \frac{Ca}{Cg.sum} \times 100\%$$

Where

Ca : Number of classification pixel class

$Cg.sum$: Total ground truth pixel

4.2 User Accuracy

User Accuracy is a measure of how well the classification is performed. It indicates the percentage of probability that the class which a pixel is classified to on an image actually represents that class on the ground.

$$\text{User accuracy} = \frac{Ca}{Ci.sum} \times 100\%$$

Where:

Ca : Number of classification pixel class

$Ci.sum$: Total classification pixel

4.3 Assessment Accuracy

Table 1. Covariance Matrix of Ground Truth Pixel

Classification Pixel	Ground Truth Pixel								
	Class	Forest	Urban	Industrial area	Agriculture	Fish pond	Karts	Water	Total Classified pixel
	Forest	5,624,999	0	296	0	0	0	543	5,625,838
	Urban	0	3,477,220	1,875	1,256	11,940	345	0	3,492,636
	Industrial Area	29	0	17,558	0	0	0	0	17,587
	Agriculture	3,234	2,520	0	8,992,098	985	0	346	8,999,183
	Fish pond	468	0	6	0	936,811	0	108	937,393
	Karts	9,830	0	0	0	0	2,642,117	0	2,651,947
	Water	620	150	2	12	3,241	765	21,464,421	21,469,211
	Total Ground Truth pixel	5,639,180	3,479,890	19,737	8,993,366	952,977	2,643,227	21,465,418	43,193,795

Table 2. Covariance Matrix of Training Sample Pixel

Land Classification	Water	Karts	fishpond	agriculture	urban	forest	industrial area	Row Total
Water	60		11					71
Karts		21		1	1	1		24
fishpond	8		21					29
Agriculture				40	2	1		43
Urban	1		1	3	42		2	49
forest		6		5		47		58
Industrial Area	1				7		18	26
Column Total	70	27	33	49	52	49	20	300

Table 3. Assessment accuracy of Matrix and kappa hat result

Land Classification	Producer Accuracy	Omission Error	User Accuracy	Commission Error
Water	85.70%	14.30%	84.51%	15.49%
Karts	77.77%	22.23%	87.50%	12.50%
fishpond	63.63%	36.36%	61.91%	38.09%
Agriculture	81.63%	18.37%	93.03%	6.97%
Urban	80.76%	19.24%	85.72%	14.28%
forest	95.91%	4.09%	89.66%	10.34%
Industrial Area	90.00%	10%	69.24%	30.76%
Overall Accuracy= 83%				
Kappa Hat= 0.82				

5. Result

The study of Mamminasata metropolitan cover area utilizing sentinel 2B satellite image data and using the maximum likelihood classification approach to obtain land cover data. Land classification was divided into seven classes (Forests, Cities, and Industrial Estates, Agriculture, Ponds, limestone mountains and water bodies). The results of this classification produce data with an overall accuracy of 83%. There is a storage classification caused by the same brightness, colour and texture equation, for example industrial and urban areas, water bodies, karts and ponds.

6. References

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