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Remote Sensing Application With Validation Test For Inland Waters Detection In Loa Kulu Minapolitan Area, Kutai Kartanegara Regency

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Abstract

Loa Kulu minapolitan is an area producing land fisheries products in Kutai Kartanegara Regency, Indonesia. The demand for fishery products both within and outside this region is continuously increasing. However, intensification efforts seem to unable to fulfill market demand. Furthermore, the efforts are constrained by information unavailability for aquaculture potential land. Land detection for inland waters in research location is the first step to provide manageable water land to increase fisheries production in this region. This paper is preliminary research aimed to draw an existing map of inland waters distribution at the research site. Google image interpretation and field observations techniques are used to detect the spatial distribution of inland waters. Moreover, the methods for validation processes or data accuracy are point sampling and area sampling accuracy. The analysis results of point sampling accuracy in this study were 80.99% (acceptable result). The percentage of bias at point sampling accuracy is 19.01% (acceptable result). Total bias value which is caused by differences in time taken for two data types. Besides, the object size is smaller than the image resolution ability. While the results of the area sampling accuracy in this study indicate that swampland use has an accuracy of 100%, rice fields 99.91% and rivers 99.50% (acceptable result). In conclusion, study result is considered relevant to be the initial description of inland waters distribution map as an input for research on determining potential land for inland aquaculture development to increase fisheries production at the research site.

Keywords: digital analysis, remote sensing, inland waters detection, fisheries sustainability

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1. Introduction

The study by FAO, (2012); Bappenas, (2014) said that the challenge in developing aquaculture is about increasing the production of fisheries commodities that should pay attention to the carrying capacity of the environment. One of the regions in Indonesia which has considerable potential aquatic land and fisheries production is Kutai Kartanegara District with Loa Kulu District as the Minapolitan Area. The total land area of the Loa Kulu Subdistrict is 104,570 ha, with more than 9,744 ha constituting inshore land (BPS

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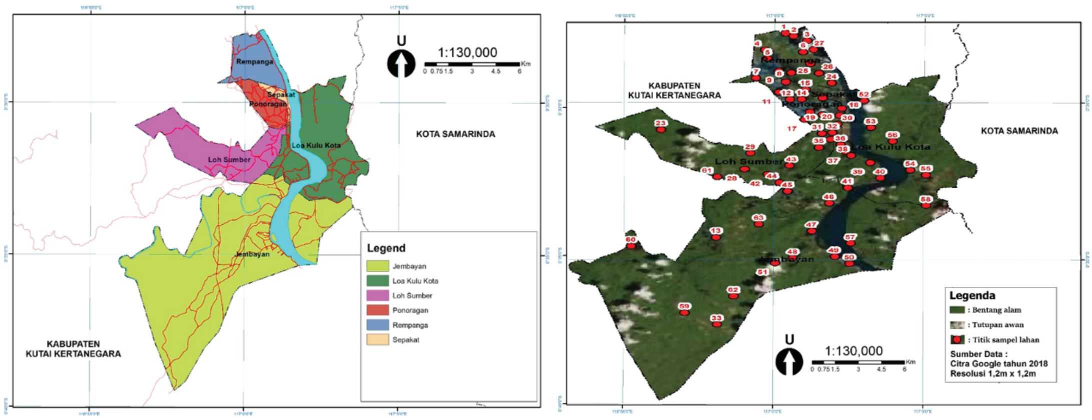
East Kalimantan, 2018). With this total area, the inland water that has been cultivated in the Loa Kulu District is only 1,305.85 ha (59.65%). Therefore, there is still approximately 1,319.2 ha remaining up to 883.31 ha (40.35%) of inland water areas and 11,042.08 ha of non-aquatic land that has not been identified yet (Bappeda Kutai Kartanegara, 2015). The Loa Kulu Minapolitan Area is an area with an economic function based on inland aquaculture which has existed since 2011. The Government of Kutai Kartanegara through the DPKP has made a series of production targets accompanied by efforts to increase fisheries production but faces challenges to meet the increasing market demand both within and outside the region. The availability of spatial data becomes very important as a basis for assessing land suitability for aquaculture activities. However, the availability of detailed scale spatial data especially for aquatic land is still very minimal in Indonesia. The limitations of this spatial data can be overcome by remote sensing detection and validation technology (Setiawan et al., 2014, Wahidin et al., 2015)

Remote Sensing Technology (Inderaja) is increasingly developing through the presence of various satellite systems with various missions and sensor technology. The application of remote sensing satellite has been able to provide data or information about the natural resources of the plains and marine natural resources regularly and periodically (Wahyunto et al., 2018). Field validation (ground truth) is carried out to check the truth of the analysis results, including observing the state of the aquatic land and the type of surrounding land use. The final results of this study aim to make an existing map of the distribution of terrestrial waters in the corrected research location. This research was conducted with a series of secondary and primary data detection and validation through image interpretation and field observation results through simple statistics. The final results of this study are the first step for further research. The follow-up research will examine the provision of land waters that are capable of being managed to increase the amount of fisheries production in the Minapolitan area of Loa Kulu. This research was conducted with a series of secondary and primary data detection and validation through image interpretation and field observation results through simple statistics. The final results of this study are the first step for further research. The follow-up research will examine the provision of land waters that are capable of being managed to increase the amount of fisheries production in the Minapolitan area of Loa Kulu.

2. The Study Location

The Loa Kulu Minapolitan area is part of the Loa Kulu District administration area, Kutai Kartanegara Regency, East Kalimantan Province. This area was formed through the

Decree of the Regent of Kutai Kartanegara Number 234 / SK-BUP / HK / 2011 with an area of 13,231.24 hectare with it's main function as a Minapolitan area based on inland aquaculture. This area consists of six villages namely Loa Kulu Kota Village, Rempanga Village, Jembayan Village, Ponoragan Village, Loh Sumber Village, and Sepakat Village. More clearly about the description of the Loa Kulu Minapolitan Area can be seen in Figure 1.



(a) (b)

Figure 1: The Loa Kulu Minapolitan area (a), distribution of land water samples (b).

3. Literature Review

3.1. Interpretation of Land Use

The initial detection of land use information in this study is to interpret remote sensing data in the form of Google Images. Analysis of remote sensing data is an activity to re-recognize all the appearance of objects that have been captured by satellite sensor devices. Information on remote sensing land cover can be interpreted based on color, texture, size, shape, association, shadow, location, and pattern on sensory satellite imagery. However, as is generally the case for satellite sensing optical sensors, land cover is identified from the original color composite image of a combination of red, green and blue bands using both digital classification and visual interpretation methods (Sari, 2016).

Image interpretation based on texture analysis is measured by the statistical value of dependencies, distribution, and connectedness between pixels and neighboring pixels. Second-order texture analysis was used for image interpretation in this study. Second-order texture analysis is calculating many scalar textures from the concurrency matrix in the first order using 8 texture scalars developed by Haralick et al. (1973); Sari, (2016), namely Mean, Variance, Homogeneity, Contrast, Dissimilarity, Entropy, Angular second moment and Correlation.

The optimal interpretation results can be generated by testing the concurrency matrix and calculated using several parameters. The parameter in question is the size of the pixel box and the angle of a pixel looking at the neighboring pixels. Classification of digital land cover based on textures calculated using pixel boxes has advantages and disadvantages. The advantage is the level that is in the class of closing land that is narrow like a river or the road results are not good, for this reason, the analysis needs to be equipped with a ground check method or check in the field.

3.2. Data Validation

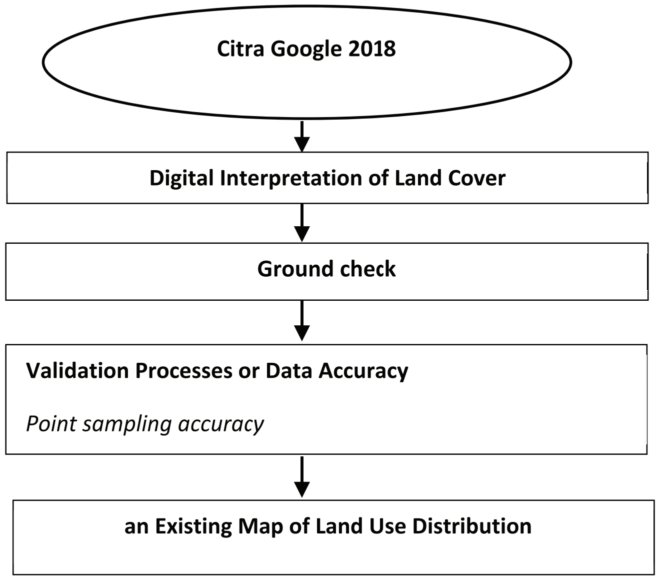
Validation of field satellite image data (ground truth) is done to check the truth of the results of land use interpretation, including observing the condition of the land in the form of location and area of the type of use (Murthy et al. 1995; Wahyunto et al. 2018). Accuracy testing is very important in every research result of each type of remote sensing data. The level of data accuracy greatly affects the amount of user trust in each type of remote sensing data. Accuracy testing for the detection of aquatic land conditions and their distribution as well as the classification of other types of land use or closure is done in two ways, namely: (1) sampling accuracy point and (2) area sampling accuracy. An overview of the stages and process of analysis in this study is illustrated in Figure 3.

Point sampling accuracy follows the method as suggested by Sutanto, (1994) in Wahyunto et al. (2018). The steps taken are (i) conducting field checks on 63 sample points selected from each class of land use or closure, for checking water areas to be carried out more intensively. Each type of land use or closure was taken by several area samples based on the homogeneity of their appearance and tested in the field, (ii) assessing the compatibility of the analysis results of Google 2018 imagery with the actual conditions in the field, and (iii) making confusion matrices on each type of land use or closure from the results of analysis of digital data on satellite images, so that the level of accuracy is known.

Accuracy of analysis is made in several classes of X which are calculated by the formula:

$$MA = \frac{Xcrpixel}{Xcr + Xo + Xco} \tag{1}$$

MA: Accuracy of analysis/classification



Source: Wahyunto et al. (2018)

Figure 2: Current stages of land use analysis.

Xcr: The correct number of pixels/site class

Xo: Number of pixels/class X site that goes to another class (omission)

Xco: number of pixels / additional class X site from another class (commission)

Area sampling accuracy is performed on land uses that are diverse such as rivers, rice fields, swamps, ponds, KJA, and settlements. Some of the land samples were examined in detail in the field, to find out the deviation between 'watershed area results from satellite image analysis' and 'the extent of the results of the field studies'. The sample area is a block size of 10 x 10 km or an area of 10,000 ha (in satellite images measuring 340 x 340 pixels). Each sample area (block) of the validation test is then divided into 100 segments. One segment is 1 km x 1 km or 100 ha. The number of sample segments observed and measured in the field to study the level of accuracy and accuracy of the analysis was determined randomly (stratified random sampling) and set at 5% or 5 segments of each sample block (Gallego, 1995; Shushil Pradan, 1999). Measurement of the land area of land in representative samples (segments), used mobile phone equipment with AVENZA applications connected to GSM networks. To then explore the entire segment area.

4. Research Method

The research method used is image interpretation techniques, field observations, and data validation using the method of point sampling accuracy and area sampling accuracy. Image interpretation is done on Google Image data in 2018 with a resolution of 1.2 x 1.2 pixels. Field observations are used to detect and correct the spatial distribution of inland waters as a result of the interpretation of Google's image data in the previous stage. The process of data validation uses the method of point sampling accuracy and area sampling accuracy.

The use of existing land in the research area was analyzed using secondary data and primary data. Secondary data in the form of Google Images in 2018 with a resolution of 1.2 x 1.2 pixels. Primary data is the result of field observations, then the two data are combined to get the expected data accuracy. Through the steps of analyzing land use as follows:

4.1. Digital Interpretation of Land Cover

Digital interpretation of land cover in this study was conducted on an area of 13,231.24 ha. The land is in coordinates between 116 ° 55'18 "BT - 117 ° 4'01" BT and 0 ° 27'14 "LS - 0 ° 39'25" LS. The land consists of six villages, namely Loa Kulu Kota Village covering 2,753.73 Ha, Rempanga Village covering 867.41 Ha, Jembayan Village covering 7,312.34 Ha, Ponoragan Village covering 449.90 Ha, Loh Sumber Village covering an area of 1,684.97 ha, and Villages Agree to an area of 162.89 Ha.

The step to produce the optimal interpretation is to test the land in the image using second-order texture analysis. This analysis method uses several parameters. The parameter in question is the size of the pixel box and the angle of a pixel looking at the neighboring pixels. Calculates the area through the number of pixel boxes (1.2 × 1.2 pixels). Digitally testing several angles of a pixel seeing neighboring pixels (0 °, 45 °, 90 °, 135 °). At this stage, a variety of land cover in the form of swamps, rivers, ponds, cages, rice fields, settlements is produced. Table 1 provides information about the type, area and pixel size of land use based on the interpretation of Google Images.

The Google image of 2018 used in this study is image data that has a resolution of 1.2 x 1.2 pixels. The meaning of this is a pixel box representing an image measuring 1.2 meters x 1.2 meters in the field. Table 1 provides information that the greater the number of pixels in similar land use, the more land area in the type of land use.

Table 1: Type, area, and number of land use pixels based on Google Image interpretation.

No	Types of Land Use	Large (ha)	Number of pixels
1	Rawa	23.26	161.500
2	Sungai	826.43	5.739.089
3	Kolam	1137.19	7.897.186
4	Keramba Jaring Apung	167.85	1.165.625
5	Sawah	470.23	3.265.487
6	Permukiman	10606.28	73.654.750
	Total luas 6 desa	**13.231.24**	**91.883.637**

Source: Google Image Interpretation, 2018

4.2. Ground check or Field Observation

The process of image interpretation produces aquatic lands to be tested in the next process, namely ground check. The ground check process with the help of the observation form. The location of these field observation sample plots is practiced wherever possible in areas with high accessibility and can represent all existing classes, so that information about the condition of aquatic land and other land uses can be known and monitored quickly and easily. Field validation was conducted to check the correctness of the results of the analysis, including observation of points, area, and type of land use (Murthy et al. 1995; Wahyunto et al. 2018).

The geographical position of the observation location is determined by measuring the coordinates of the observation location in the field using a tool in the form of an AVENZA application. Data or information from field observations in sample plots will be processed and "matched" or matched with satellite image data for the main source of information in refining the results of analysis and classification of land use or closure. To make field observations, the observation form is used. The results of field observations related to land area and land use can be seen in table 2.

Through table 2 it can be seen that there are corrections to the number of pixels and the area of four land uses, namely rivers, ponds, rice fields, and settlements.

4.3. Land Use Data Validation

Validation of data on the detection of location and area of water and non-aquatic land was carried out in two steps, namely:

Table 2: The type, area, and number of pixels of land use based on field observations in 2019.

No	Types of Land Use	Large (ha)	Number of pixels
1	Rawa	23,26	161.500
2	Sungai	830,61	5.768.125
3	Kolam	1.137,97	7.902.569
4	Keramba Jaring Apung	167,85	1.165.625
5	Sawah	469,80	3.262.526
6	Permukiman	10.601,75	73.623.291
Total luas 6 desa		**13.231,24**	**91.883.637**

Source: Field Observation Results, 2019

4.3.1. Point Sampling Accuracy

The results of point sampling accuracy analysis in this study found that the level of accuracy of the analysis in detecting terrestrial waters was 80.99% meeting the required percentage of not less than 70%. The commission or the bias value of the corrected pixels is 19.01% to meet the minimum limit of the expected percentage of less than 30%. Thus the results of point sampling accuracy in this study are the acceptable result to be an existing description of the distribution of existing water and non-water land-use points at the study site.

The variety of land use interpretations that contribute to a bias of 19.01% is for the use of rivers, swamps, and ponds. The level of accuracy for use of river land is caused by differences in the time of taking and recording two different types of data. Secondary data in the form of google imagery recorded in 2018 is carried out when there is a possibility of river water tide, possibly in the afternoon or early morning so that the pixels that show the river is more compared to when the observations were conducted are not the season of tidal rivers, namely January in the afternoon. Commissions or biases can be found on the edges or boundaries of the land that have different ranges, especially in river lands, similarities in pixel values or similarities inland performance occur on the banks of the river which are ex empty land which is part of the settlement.

The level of accuracy of the use of swampland is 33.33%, the commission or bias of 77.77% on the interpretation of swampland use caused by the performance of swamps captured by Google imagery has similarities with paddy fields, this is possible at the time of recording Google Images on In 2018, there are quite mature plants in the paddy fields and the greenness of the plants is almost the same as the grass weeds in swamps. The biggest bias contribution is to use pool land with a level of accuracy of 0% meaning that the pool is not detected at the time of interpretation of Google Images. The size of ponds generally in the field is 1 x 9 meters while the largest resolution of the google image 1.2 x 1.2 meters is not yet able to interpret pond objects with a width of fewer than 1.2 meters, which looks just like a 9-meter line. Calculation of the level of accuracy in the key areas is presented in table 3.

Table 3: Calculation Of Accuracy Sampling Points.

Field Observation	Interpretation Results							Total	Overall accuracy of Interpretation	Omisi (pixel)	Accuracy of Analysis (%)
	Sungai	Danau	Sawah	Rawa	Kolam	Keramba Jaring Apung	Permukiman				
Sungai	5,272,839	0	0	0	0	466,250	29,036	5,768,125		495,286	91.41
Danau	0	0	0	0	0	0	0	0		0	0
Sawah	0	0	2,446,895	0	815,632	0	0	3,262,526		815,632	75.00
Rawa	0	0	2,961	53,834	102,283	0	2,423	161,500		107,666	33.33
Kolam	0	0	815,632	107,667	0	0	6,979,271	7,902,569		7,902,569	0
Keramba Jaring Apung	466,250	0	0	0	0	699,375	0	1,165,625		1,165,625	60.00
Permukiman	0	0	0	0	6,979,271	0	66,644,020	73,623,291		6,979,271	90.52
Total	5,739,089	0	3,265,487	161,500	7,897,186	1,165,625	73,654,750	91,883,637	80.99%	17,466,050	
Komisi (pixel)	466250	0	818,592	107,667	7,897,186	1,165,625	7,010,750	17,466,050			

4.3.2. Area Sampling Accuracy Uji

Indicating that switching land use has an accuracy rate of 100%, rice fields 99.91% and rivers 99.50%. According to Gallego (1995) and Sushil Pradan (1999) in Wahyunto et al. (2018), the level of accuracy of the satellite image analysis for detection of watershed areas above 99% is acceptable. Show that the percentage above is 99% and even the accuracy area has a precision accuracy of 100%, it can be interpreted that the area of each land use is obtained from the detection and validation data is considered very good (acceptable result) and relevant as a basis for knowing the extent of existing use of water and non-aquatic land. The results of testing and measuring water in each segment sample are presented in table 4.

Table 4: Calculation of area sampling accuracy.

Block/Area (Type of Inland Waters)	Expected Accuracy	Validation Results	Deviation	Information
	%	%	%	
Sungai dan anak sungai	70-100	99.50	0.50	acceptable
Rawa	70-100	100	0	acceptable
Sawah	70-100	99.91	0.09	acceptable

Source: Analysis Results, 2019

Therefore, the results of detection of inland waters and area data validation tests are relevant and can be used as the basis for an overview of the existing map of the distribution of inland waters at the study site.

4.4. Corrected Existing Land Use Map

Map of existing land use that will be produced in this study informs the distribution of land use both waters and non-waters in the Minapolitan Area Through the ground check process and data validation, maps of inland waters are corrected for position and area. Land use in the Loa Kulu Minapolitan Area is presented on a scale of 1: 25,000 consisting of 13 land use units. Thirteen units of land use, then grouped into 2 (two) main groups, namely groups of aquatic land 4 (four) units and non-aquatic land consisting of 8 (eight) units of land use table 5 and Figure 3.

TABLE 5: Area and percentage of land use corrected.

No	Types of Land Use	Large	
		Ha	%
I	**LAHAN PERAIRAN**		
	a. Rawa	23.26	0.18
	b. Sawah Irigasi	317.6	2.40
	c. Sawah Non Irigasi	152.2	1.15
	d. Sungai	830.61	6.28
	e. Kolam	1137.97	8.60
	f. Keramba Jaring Apung	167.85	1.27
	Sub-total	**2,629.49**	**19.87**
II	**LAHAN NON PERAIRAN**		
	a. Emplasemen	32,62	0,25
	b. Hutan Belukar	2.130,21	16,10
	c. Hutan Sejenis	1.201,31	9,08
	d. Permukiman	337,21	2,55
	e. Kebun Campuran	1.235,54	9,34
	f. Pertambangan	143,3	1,08
	g. Semak	617,78	4,67
	h. Tegalan/Ladang	4.903,78	37,06
	Sub-total	**10.601,75**	**80,13**
	Total	**13.231,24**	**100**

Sources: Google Image Interpretation, 2018, Field Observation Results, 2019, Results of Analysis, 2019

The findings of this study were that the study sites consisted of non-aquatic land covering an area of 10,601.75 ha (19.87%) and a land area of 2,629.49 ha (80.13%). Land use land consists of swamps of 23.26 ha (0.18%), rivers 830.61 ha (6.28%), ponds 1,137.97 ha (8.60%), floating net cages 167.85 ha (1.27%) and rice fields 469.80 ha (3.55%). The use of non-aquatic land covering 10,601.75 ha (80.13%) consisted of emplacement with an area of 32.62 ha (0.25%), thicket forest with an area of 2,130.21 ha (16.10%), similar forest with an area of 1,201.31 ha (9, 08%), settlements covering 337.21 ha (2.55%), mixed gardens covering 1,235.54 ha (9.34%), mining covering 143.3 ha (1.08%), bushes covering an area of 617.78 ha (4.67%), and moor area of 4,903.78 ha (37.06%). The map of corrected land use can be seen in Figure 3.

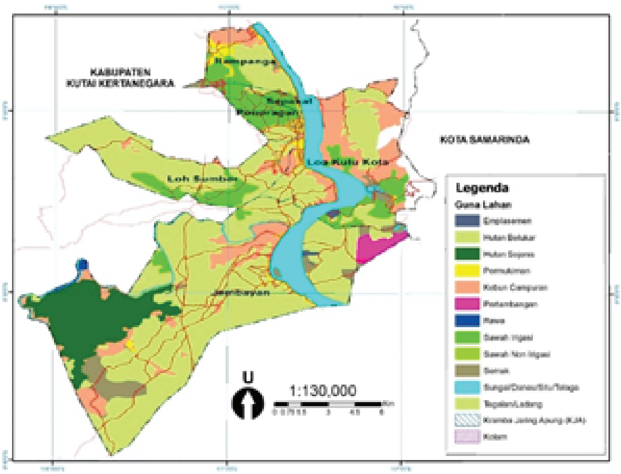


Figure 3: Map of land use corrected inland waters (*Source: Results of Analysis, 2019*).

5. Results and Discussion

The results of point sampling accuracy in this study found that the percentage level of accuracy of the analysis in detecting terrestrial waters was 80.99%. This value exceeds the required percentage limit which is not less than 70%. The commission or the bias value of the corrected pixels is 19.01%. This value meets the expected minimum percentage of less than 30%. Thus the results of point sampling accuracy in this study are the acceptable result to be an existing description of the distribution of existing water and non-water land-use points at the study site.

The results of the area sampling accuracy in this study indicate that swampland use has an accuracy rate of 100%, rice fields 99.91% and rivers 99.50%. According to Gallego (1995) and Sushil Pradan (1999) in Wahyunto et.al (2018) the level of accuracy of satellite image analysis for the detection of watershed areas above 90% is considered to be very good (acceptable result). Thus the results of the sampling accuracy area in this study have been very good (acceptable result) and relevant as a basis for knowing the extent of existing uses of water and non-aquatic land.

The findings in this study were the Minapolitan Loa Kulu area consisting of 19.87% (10,601.75 ha) of aquatic land and 80.13% non-aquatic land (2,629.49 ha). Land use land consists of swamps of 23.26 ha (0.18%), rivers 830.61 ha (6.28%), ponds 1,137.97 ha (8.60%), floating net cages 167.85 ha (1.27%), rice fields 469.80 ha (3.55%). As well as non-water land uses consist of settlements covering an area of 10,601.75 ha (80.13%).

6. Conclusion and Recommendation

The research on detection and validation of land use aims to map land use. The data types used in this study are primary data and secondary data. Secondary data in the form of Interpretation of Google Images in 2018 and primary data in the form of field observations. Detection of land use with two types of data has advantages in terms of being able to provide better results of accuracy than similar studies that only use one data type. The disadvantage in research with these two types of data is that it allows a bias or cururation to the accuracy of location points and the extent of land use. Percentage of bias or curing accuracy of land-use points (point sampling accuracy) that can be tolerated according to Wahyunto et. al (2018) is less and not more than 30%. The percentage of bias or accuracy of the area of land use (area sampling accuracy) that can be tolerated according to the study of Gallego (1995) and Sushil Pradan (1999) in Wahyunto et.al (2018) is not less than 90%.

The results of land use detection in this study were validated using two stages of data validation, namely, point sampling accuracy and area sampling accuracy. The results of the sample accuracy point or point sampling accuracy in this study were 80.99% (acceptable result). Commission or value of bias at point sampling accuracy of 19.01% (acceptable result). While the results of the test area accuracy (area sampling accuracy) in this study indicate that swampland use has an accuracy level of 100%, rice fields 99.91% and rivers 99.50%. According to Gallego (1995) and Sushil Pradan (1999) in Wahyunto et.al (2018) the level of accuracy of the land area of waters above 99% is considered to be very good (acceptable result). The conclusions in this study are the results of detection and validation of relevant land use data and can be used as a basis to find out the location and extent of existing land and water use in the Loa Kulu Minapolitan Area.

The findings of this study are the Minapolitan Loa Kulu area consisting of 10601.75 ha of water area (19.87%) and 2,629.49 ha of non-aquatic land (80.13%). Land use land consists of swamps of 23.26 ha (0.18%), rivers 830.61 ha (6.28%), ponds 1,137.97 ha (8.60%), floating net cages 167.85 ha (1.27%), rice fields 469.80 ha (3.55%). As well as non-water land uses consist of settlements covering an area of 10,601.75 ha (80.13%).

The contribution of this research to the next research is in the form of input to researchers who use two types of data in the land use detection process to pay attention to the timing of taking two types of data. It is recommended that researchers minimize the difference in seasons such as the tides and low tides in recording secondary data and primary data collection. This is useful to anticipate the amount of percentage bias data that will make the results do not meet the expected percentage of accuracy.

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