Seagrass Distribution Area Computations At Tidung Island, Seribu Islands Regency Jakarta Province, Indonesia

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Abstract. Seagrass ecosystem posses important ecological aspects like primary production, biota habitat, sedimentation catching area, nutrient recycling, and CO_2 absorptions. Seagrass plantation destructions may due to antropogenic activity causing seawater decreasing quality and also coastal environmental. Development activity at coastal region like soil hoarding, landfill and coastal transportation also posses huge contribution onto seagrass ecosystem damaging. Seagrass ecosystem monitoring could be conducted utilising remote sensing technology. The study is to compute and to map the distribution of seagrass areas exists on Tidung Island, and evaluate the changes to some extent. Field data collections and satellite image processing were conducted. The supervised classification performed on Sentinel 2A satellite images year 2017 and 2019 respectively. The image classification results indicated four classes, namely non-seagrass, solid seagrass, medium seagrass and rarely seagrass. In 2017 seagrass areas obtained 43.47 hectares (0.435 km^2) and non seagrass of 217.93 hectares (2,178 km^2), but in 2019 the seagrass areas of 58.67 hectares (0.587 km^2) and non-seagrass of 202.73 hectares (2,027 km^2). There indicates a change in the seagrass into non-seagrass areas around 39.89 hectares (0.399 km2) and non-seagrass which became seagrass area of 24.69 hectares (0.247 km^2). The accuracy value obtained was 74.90 %. However, it has been succesfully conducted computations on alteration seagrass areas and mapping spatially at Tidung Island, Indonesia.
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Introduction

Seagrass was called as plantation which has flower (Angiospermae) living at shallow seawaters environment, estuarine which posses high salinity contain sandy substrat, sandy mud, sofly mud and coral (Kiswara dan Hutomo 1985). Seagrass ecosystem posses important ecological such as primary production, biota habitat, sedimentation catching area and nutrient recycling (Azkab 1999). Beside, seagrass ecosystem also posses big potential in CO2 absorption which as main causing global warming (Setiawan *et al.* 2012).

Destroying of seagrass ecosystem could be due to antorpogenic activity which causing seawater decresing quality and also environment activity (Fajarwati *et al.* 2015). Construction activity at coastal region such as soil hoarding, landfill activity and seatransportation activity also posses huge contributions onto seagrass ecosystem damaging (Supriyadi *et al.* 2018).

Seagrass ecosystem monitoring could be conducted by utilising remote sensing technology. Using remote sensing technology can be a very provitable alternative if utilizing on wide area. Remote sensing. Also remote sensing can obtain data repetition in order to make temporal analyzing (Syah 2010). The objective of this research are to mapping seagrass expanse areas using Sentinel 2A image and investigate change of seagrass areas of year 2017 and 2019 at Tidung Island, Northern part of DKI Jakarta Province

Methods

Location and Data

This reserach divide into 2 step such as field collecting data and data analyzing. Collecting data on field conducted during 7 February 2020 until 9 February 2020 at Big Tidung island and Tiny Tidung Island with geographical coordinate 5°47' S - 5°49' S and 106°28' E - 106°33' E (Figure 1). Data analyzing conducted at Marine Remote Sensing, Department of Marine Science and Technology, Faculty of Fisheries and Marine Sciences, IPB University Bogor.

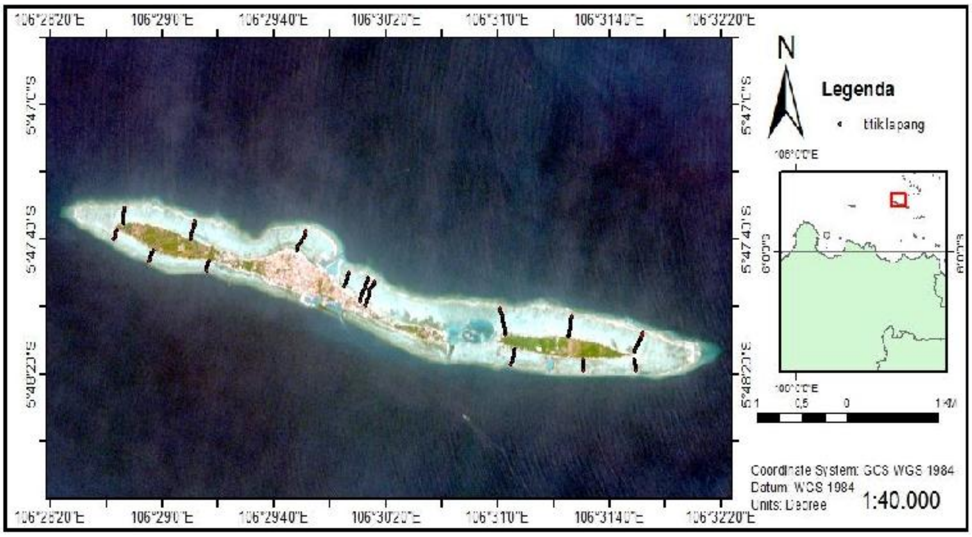

Figure 1 Research Location

Equipment used in the field data collections such as GPS hand, camera, quadratic transect, diving tools, seagrass identification card and pencil for writing report. Then, image data processing tools like personal computer and laptop, image processing aplication, for example ENVI 5.1, ArcMap 10.4.1. and *MS Office*. Materials used in this research such as Sentinel 2A satellite image, with acquisition on May 25, 2017 and Dec, 11, 219 which can be dowloaded from website http://earthexplorer.usgs.gov/.

Research Precedures

Pre-research starting with Sentinel 2A satellite image processing such as geometric correction, atmosferic corrections and water column corrections. Field data collected used as reference in the classification process as guided supervised and as testing point to calculate acuration level from yielded map. Classification results then compare yearly in order to investigate seagrass area diffrence from year by year

Field Survey

Field data collecting about seagrass areas cndition conducted with *proportional random sampling method. Propotional random sampling conducted* in order to find sample point on the spot, sample pount amount, decided based on representative areas which mapping (Prayuda 2014). Field data collections using quadratic transect of 10mx10m suitable with sentinel image spation resolution. Sample point starting from coastal perpendicular to coastal edge. Field data collection amount to 240 point, consist of 96 points for classifications and 144 point for accuration test. Data collected based on this method such as seagrass expanse percentage which visually observe and transect photo as documentation and geogrphical positions sample point using GPS. Then, seagrass expanse percentage in every observatorial point can be classified into 3 class of density as in Table 1.

Table 1 Percentage class of seagrass expanse cover

Class		**Remarks**
Name	**Code**	
Seagrass dense	SD	Seagrass percentage cover >70%
Seagrass medium	SM	Seagrass percentage cover 30% - 70%
Seagrass rarely	SR	Seagrass percentage cover 1% - 30%

Source: Federal Geographic Data Committee / FGDC (2012)

Image Processing

Pre-processing

Pre-proccesing step were steps using in order to improve image quality and to increase image quality before making interpretations. Radiometric corrections using *Dark Object Substraction* (DOS) methode. Radiometric correction were to erase atmosphere effect on image. General DOS algorithm was using minimum values of satellite image. This algorithm only utilizing avalaable *digital number* on satellite image. The assuption of this methode stated that lower pixel values on certain image thats 0 (Gong *et al.* 2008*)*. Radiometric correction could be written in equation (Prayuda 2014) :

$$NP' = NP - NPmin \quad (1)$$

Where: NP' = Pixel values form correction results; NP = Image pixel values on certain channel; NPmin = Minimum pixel values

Next step was to image cropping using region coordinate limit which already cited, image cropping conducted for limit analysis area (Nugraha 2018). Furthermore geometric correction done for improving image object positions in order to suit with real positions.

Water column correction.

Water column corrections called *Depth Invariant Index, (DII) were to improve image pixel values* due to the influnce of water column which causeing pixel values differenceson the same object, but exist on difference depth (Hafizt *et al.* 2017). This method is called Lyzenga method. Lyzenga method equations stated (Lyzenga 1981) as :

$$Y = [\ln(B1)] + [\left(\frac{K}{K}\right) * (\ln(B2))] \quad (2)$$

Where: B1 : band 1 (biru); B2 : band 2 (merah); Ki/Kj : attenuation coefficient values .Values of ki/kj calculated by using next equations :

$$KiKj = a + \sqrt{a}2 + 1 \quad (3)$$

$$a = \frac{(\sigma - \sigma)}{2\sigma} \quad (4)$$

Where; σii : varian band i (blue); σjj : varian band j (green); σij : covarian band ij (blu green)

Processing.

Satellite image classifications using supervised classifications based on sample point. Algorithm which used for shallow water habitat classifications and seagrass classifications was MLH (*maximum likelihood*). Algorithm of MLH was assumed that probability for every class was the same with *training data* from field observations, on every pixel and every satellite image canal (Green *et al.* 2000). Probability calculations which known *likelihood* can be described as equation (Jayanti 2017):

$$P(i|x) = \left(\frac{P(x|i)\ P(i)}{P(x)}\right) \quad (5)$$

Where: P(i|x) = Conditional Probability of certain class i, calculated from vector x unconditional; P (x | i) = Conditional Probability of vektor x, calculated from unconditional class; P (i) = Probability form certain class i which appear froman image; P (x) = Probability from vector x

Accuration Test

Calculation of accuracy test using *confusion matrix analysis. Confusion matrix* tabes shown Table 2. Accuracy calculation yielding *User Acuracy* (UA), *Producer Accuracy* (PA) and *Overall Accuracy* (OA) (Congalton dan Green 2009). Accuration test done to observe mapping result quality

Table 2 *Confussion matrix*

		Field (j)		Line amount nj+
Image classification (i)	n11	n12	n1k	n1+
	n21	n22	n2k	n2+
	nk1	nk2	nkk	n3+
Colom amount n+j	N+1	N+2	N+k	n

Producer's accuracy (PA) = $\frac{n}{n+j}$ (6)

User's accuracy (UA) = $\frac{n}{n+i}$ (7)

Overall accuracy (OA) = $\frac{\sum_{i=1}^{k} n}{n}$ (8)

Where; k : line amount at matrix; n : amount of observations: n22 : amount of observation at colomn at -i and line at -j and $n$jj: ampunt of observationa at colomn at -j and line at -j.

Results and Discussion

General Conditions of Research Location

Tidung island is one of several island at Seribu islands Northern part of Jakarta areas. Tidung island consist of Big Tidung island and Small Tidung island. Big Tidung island as dense populated areas around 50.13 hektar (0.50 km^2) (Sihotang *et al.* 2017). Small Tidung island has area of 18.8 hektar (0.19 km^2) as unpopulated areas which has potential development for tourism. Tourism activity centre at Tidung island was in around bridge connecting Big Tidung and small Tidung island. Tidung island suitable for seagrass due to shallow water, clean, and smal wave. According to Putri (2004) kind of seagrass found in Tidung island waters such as *Cymodoca rotundata, Thalassia hemprichii* dan *Enhallus acoroides*

Classification

This classification based on field data obtained and using algoritma *Maximum likelihood approach* to obtain 2 class like seagrass class and non-seagrass class. From this classification results can be seen seagrass distributions and non-seagrass on year 2017 and 2019 as stated on Figure 2

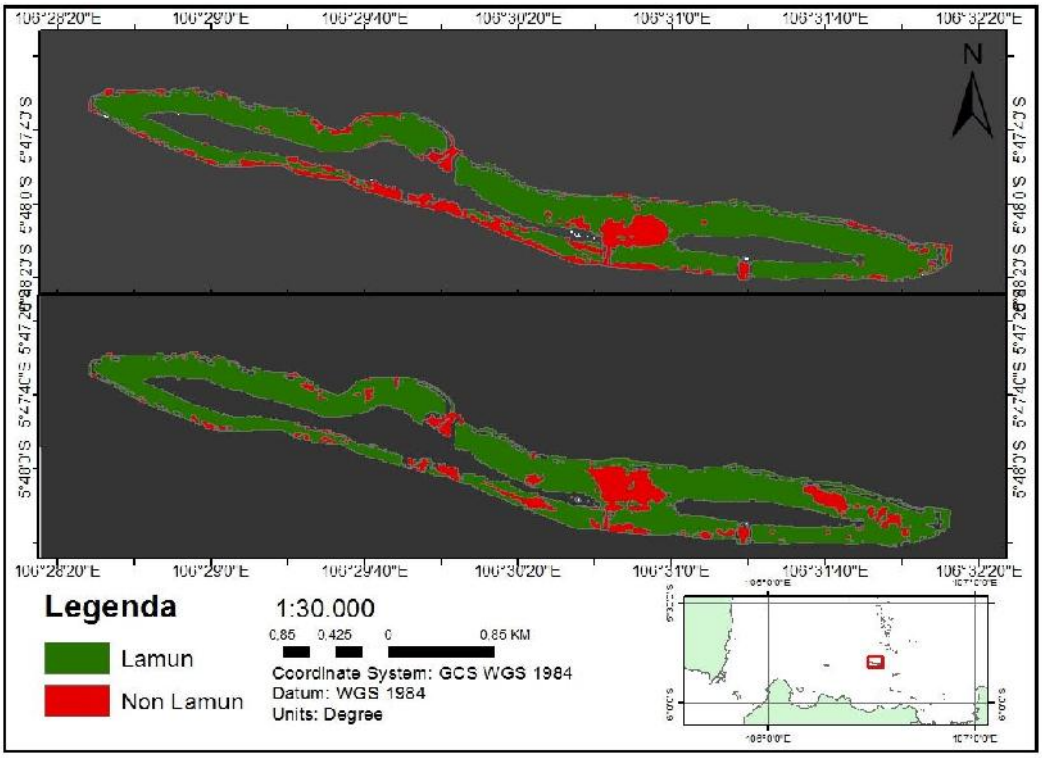

Figure 2 Seagrass expanse cover and non-seagrass a) 2017 b) 2019

From seagrass spreading and non-seagrass results from classifications using maximum likelihood algorithm as shown in Figure 3.

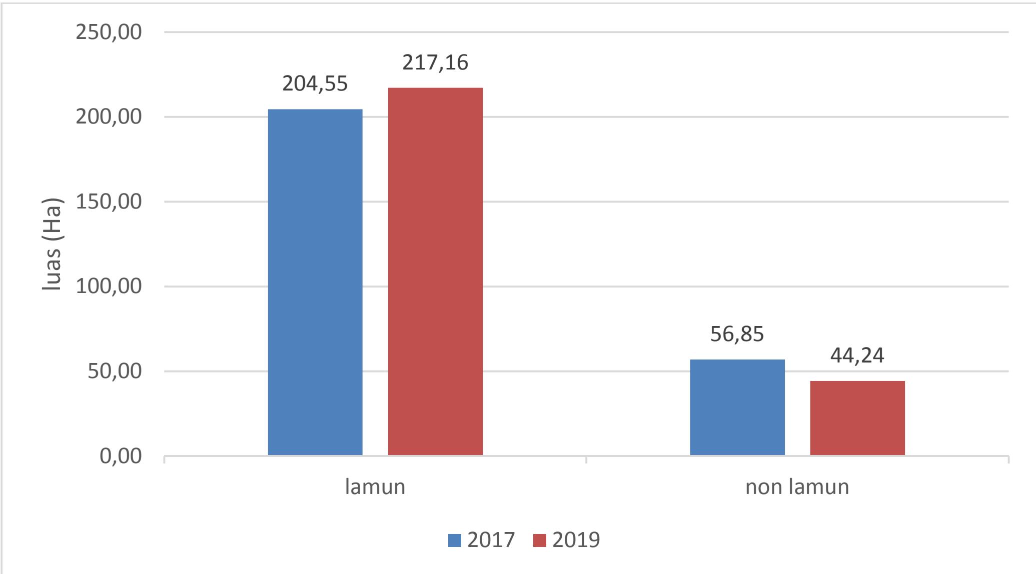

Figure 3 Seagrass expanse area and non seagrass year 2017 and 2019.

Based on data shown in Figure 3 could be seen that seagrass area experience increased. In year 2017 seagrass area about 204.55 hectare increased to be 217.16 hectare in year 2019. Seagrass area difference inversely proportional with non-seagrass area. In year 2017 the area of non-seagrass about 56.85 hectare has been decreaesd at year 2019 to be 44.24 hectare. However, image that classified as seagrass and non-seagrass again conducted classification on seagrass class such as dense seagrass, medium dense and rare seasgrass . Seagrass class grouping based on FGDC (2012). Sand grouping, coral, coral breach and macroalgae tobe grouping as non-seagrass class in order to observe detail conditions.

In Figure 4 shown spatial distribution of seagrass cover. In 2017 and 2019. Area non-seagrass in2017 and 2019 located at Big Tidung island and samll Tidung island. Besides in 2017 area non-seagrass also exist at westenr part of Big Tidung island. But in the year 2019 found area non-seagrass at northern part of Small Tidung island. Northern part of Tidung island has wide edge as dominant habitat of seagrass. Medium dense seagrass in the year 2017 which in northern part of Tidung island converse to rarely seagrass in year 2019. In the year 2019, in east auntil south direction Small Tidung island happened the increasing dense seagrass.

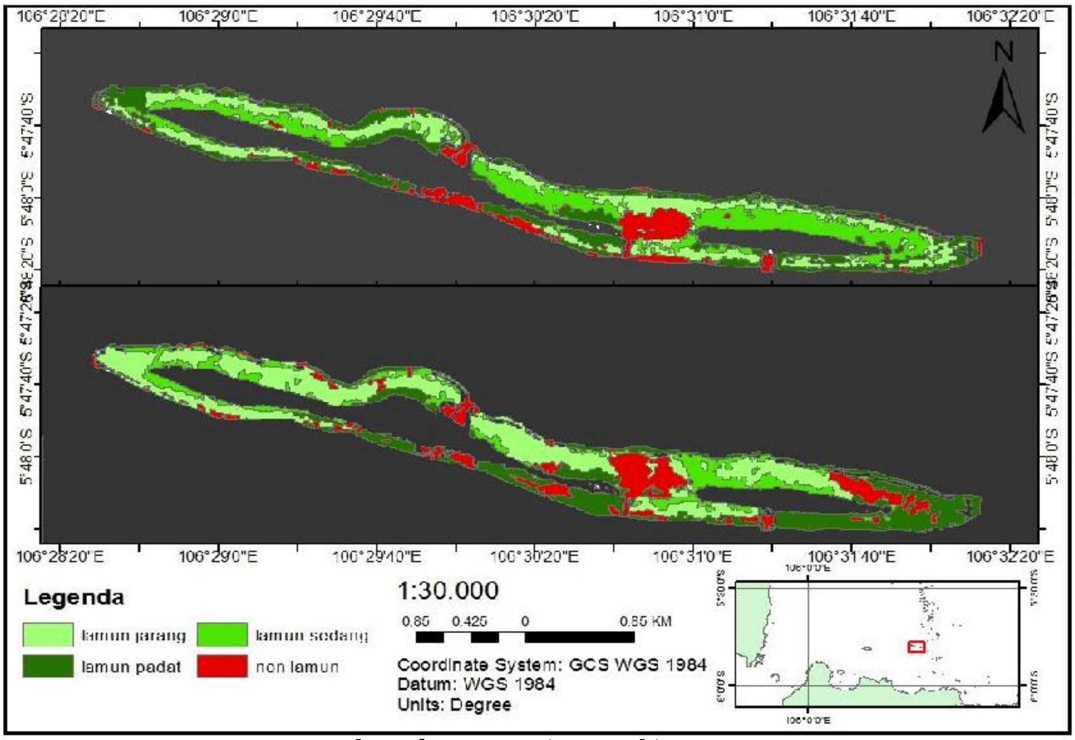

Figure 4 Seagrass cover classifications a) 2017 b) 2019

Seagrass classification resukts in 2017 and 2019 shown in Figure 5. Dense seagrass areas, medium dense seagrass area and rarely seagrass areas as shown in Firure 5.

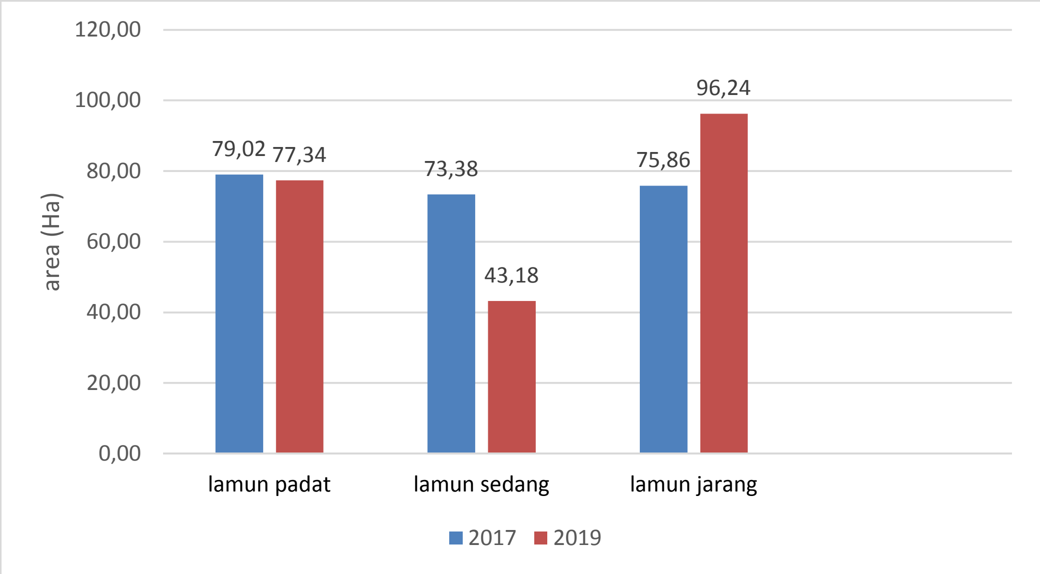

Figure 5. Seagrass classification area in year 2017 and 2019

Dense seagrass areas in 2017 as 79.02 hectare was dcreasing to 77.34 hectare in 2019. Medium dense seagrass also decrease in the year 2017 to year 2019, in 2017 medium dense seagrass about 73.38 hectare decraesing to be 43.18 hectare in the year 2019. Difference from dense seagrass and medium dense seagrass, the area of rareky seagrass increase to be 96.24 hectare in 2019 which area 75.86 hectare in 2017.

Accuracy Test

Accuracy test conducted using *confusion matrix. Analysis.* Akurasi This accuracy test produced 3 (three) accuracy values suach as *overall accuracy* (OA), *user accuracy* (UA) and *producer accuracy* (PA). Satellite image which already classified need to undertake accuracy test in order to know whether image as results of classification could be accepted or not based on certain criteria. Accuracy classification values of seagrass class in the year 2017 shown in Table 3

Table 3 Confusion matrix seagrass classification areas in year 2019

		Field data (%)				
		NS	SD	SM	SR	Total
Image classification (%)	NL	85.71	0	0	7.14	15.69
	LP	14.29	88.89	8.7	7.14	15.69
	LS	0	0	60.87	25	27.45
	LJ	0	11.11	30.43	60.71	41.18
Total		100	100	100	100	100
Producer Accuracy (%)		85.71	88.89	60.87	60.71	
User Accuracy (%)		75	50	50	80.95	
Overall Accuracy (%)		66.67				

Where : NS (Non Seagrass), SR (Seagrass Rarely), SM (Seagrass Medium), SD (Seagrass Dense).

Overall accuracy (OA) seagrass classification value in 2019 about 66.67% for four class tested such as dense seagrass, medium dense seagrass, rarely seagrass and non-seagrass. Jif based on BIG regulation (2014) that *Overall accuracy value from* image result classificationhas been satisfied. Reguation used as standar for accuracy test was interpretation results for seawater bed mapping about 60% minimal (BIG 2014)(Prayuda 2014). *User accuracy* values was accuracy value which shows exact class basecd on field data. *User accuracy* values about 50% until 81%. Smalestl *user accuracy* values found on dense seagrass class and medium dense seagrass class around 50%, which mean an half of field data for dense seagrass class and medium dense seagrass. Highest *User accuracy* value at rarely seagrass about 80.95%.

Producer accuracy values about 60% untill 89%. Smallest *producer accuracy* value was for rarely seagrass class around 36.36% and biggest *producer accuracy* value exist for dense seagrass class around 88.89%. Bentic habitat diveristy on study area and kind of image used in this research could be effected accuracy dergree obtained (Anggoro *et al.* 2015). Kind of image correlated with image spatial resolution, where high spatial resolution of image therefore produce also high accuracy value.

Seagrass expanse change area

Image already classified can be compare or overlay to see the change region. *Overlay from seagrass class* and non-seagrass produce new class such as fixed seagrass (green), seagrass class which to be non-seagrass (yellow), kelasnon-seagrass class to be seagrass (blue) and fixed non-seagrass class (red) as shown in Figure 6. That already change non-seagrass area to be seagrass in the southern Big Tidung island and change from seagrass to be non-seagrass in the region between Big Tidung and Small Tidung island and also inthw eastern seawater Small Tidung island.

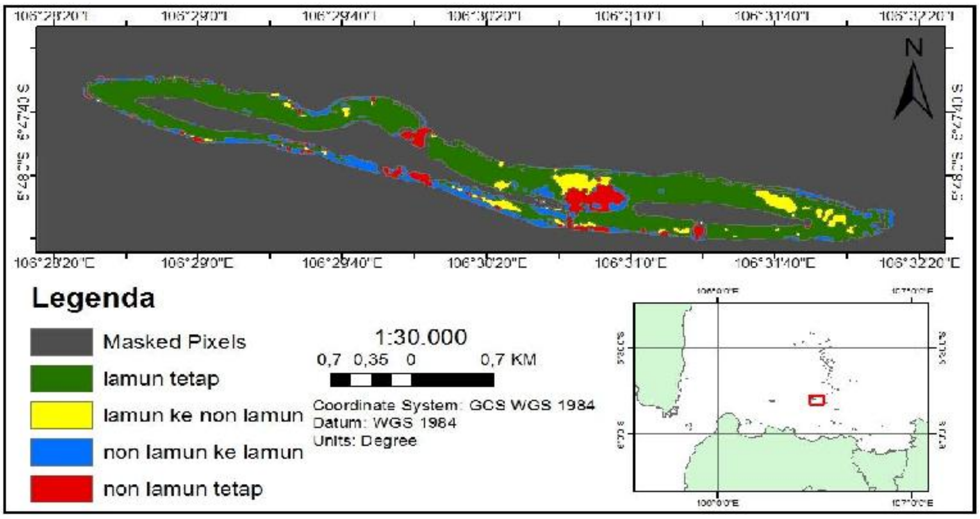

Figure 6 Seagrass expance and non-seagrass year 2017-2019

Image results as overlay change seagrass class and non-seagrass in year 2017 and 2019 can be calculated areas could be seen in Figure 7.

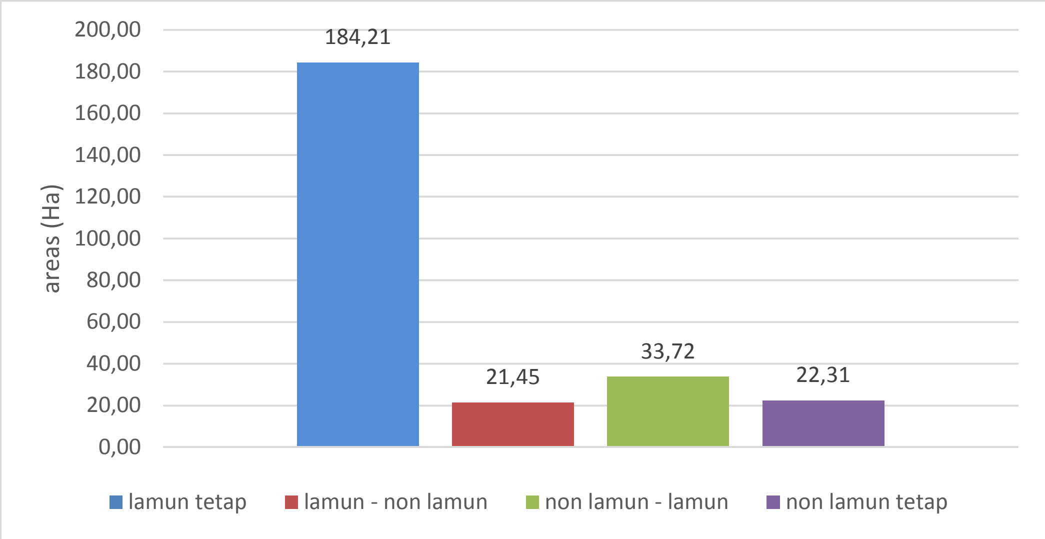

Figure 7. Area change of seagrass expanse

Areas which can not change and area change from 2017 until 2019. Seagrass which non-seagrass in year 2017-2019 about 21.45 hectare. Change area of non-seagrass to be seagrass in year 2017-2019 about 33.32 hectare,. Seagrass areas which cannot changed 2017-2019 about 184.21 hectare, and fixed non seagrass areas 22,31 hectare in 2017-2019.

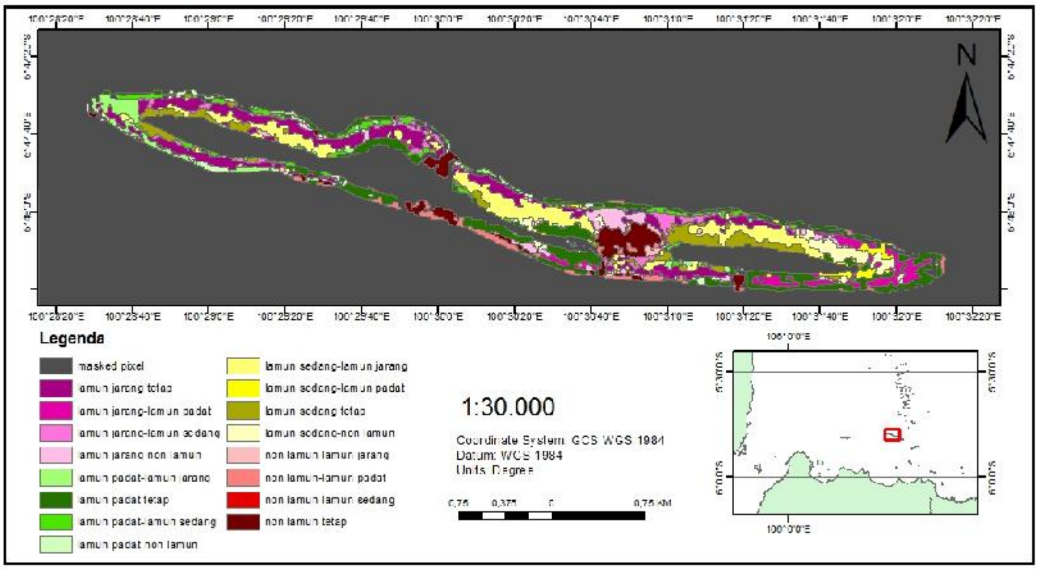

Figure 8 *Overlay seagrass covered* year 2017 until 2019

Results of *overlay* seagrass covered from year 2017 until 2019 can be grouped into 16 new class which shown region change.. The change of seagrass classification statistically seen in Table 5.

Non-seagrass class and rare seagrass class were experience area addition. Non-seagrass class have addition about 11.5 hectare (about 34.70% from intial area of rare seagrass add to be 20.38 hectare or about 26.87% from initial area of dense seagrass.. Otherrwise area of dense seagrass and middle dense seagrass have been smaller. Middle dense seagrass reduce to about 43.18

hectare or about 30.2% from initial area of it, then dense seagrass area reduce to 1.68 hectare or 2.13% from initial area.

Table 5 Statistic change on seagrass area classification 2017-2019

Area Classification (Ha)		2017 NS	2017 SD	2017 SM	2017 SR
2019	NL	18.41	5.79	9.38	11.06
	LP	10.92	47.33	5.68	13.41
	LS	0.28	11.48	21.25	10.17
	LJ	3.53	14.42	37.07	41.22
Total areas 2017		33.14	79.02	73.38	75.86
Total areas 2019		44.64	77.34	43.18	96.24
Total Changes		11.5	-1.68	-30.2	20.38
Persentage of Changed		34.70%	-2.13%	-41.16%	26.87%

Where : NS (Non seagrass), SR (Seagrass Rarely), SM (Seagrass medium), SD (Seagrass dense)

Decreasing and increasing seagrass areas can be influence by several factos such as enviromental influence and human activity. Environmental factors likr decreasing water quality, seawaves influence, tides and seacurrent. Human activity like throwing rubbish into seas, fishermen activity and coastal recreation also effected seagrass growth (Tangke 2010) (Syakur *et al*. 2017).

Conclusions

The research have been conducted in order to observ the area change of seagrass. Mapping used sentinel 2A image at Tidung Island have been obtained seagrass area in 2017 about 204.55 hectare increased to 2017.16 hectare in 2019. It has been changed seagrass into non-seagrass about 21,45 hectare and non-seagrass changed into seagrass were about 33,72 hectare. Non-seagrass classification and rare seagrass have been already increased. Non-seagrass has been increased to be 34.70% from intial area, but rare-seagrass also increased to be 26.87% from initial areas. Dense seagrass and mid-dense seagrass class experienced to decrease area. Dense seagrass were subtracted about 2.13% from initial areas but mide-dense seagrass decreased about 41.16% from initial areas. Overall accuracy that have obtained through sentinel 2A image classification in year 2019 were about 66.67%.

The next study could be done using different algortihm with supervised classification methode so that can be compared each other. Also using high resolution image can be increased accuration in order to obtain better results of computations.

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