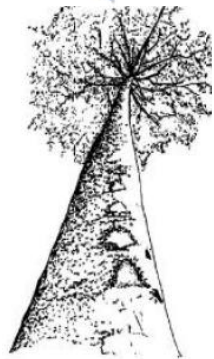




Monitoring Agroforestry for REDD+ Implementation using Remote Sensing Data and Geographic Information System: a Case Study of Repong Damar, Pesisir Barat Lampung

Cecilinia Tika Laura, Arief Darmawan and Rudi Hilmanto

**Department of Forestry Faculty of Agriculture
Lampung University**



REPONG DAMAR



- Repong Damar is a stretch of plant of damar mata kucing (*Shorea javanica*) which forms a kind of forest that is cultivated and managed by the community (Nainggolan, 2011)
- The management system of plantation that includes multiple species (main plantation is damar) cultivated and managed by the Krui Lampung Community (Mulyani, 2008)
- The Krui community defines that repong damar is a piece of land planted using agroforestry system, where various types of plants exist (Lubis, 1997).

Study Background

REDD+ (Reducing Emissions from Deforestation and Forest Degradation Plus)

REDD plus is considered to emphasize natural forests than other vegetated land use such as agroforestry, like Repong Damar

Repong Damar is a kind of multiple tree plantation (traditionally planted) that is resembling to natural forest

Repong damar is vulnerable to deforestation due to various problems (trading system, weak institutional capacity)

The implementation of REDD plus in repong damar has a potential to carry out various activity for improving management of repong damar

Research questions :

- How can Repong Damar coverage be distinguished from natural forest cover using satellite image data?
- What is the coverage extent status of Repong Damar from 1990 to 2018?
- How can FREL Repong Damar be constructed from these data?

Research Purposes:

- To determine the most appropriate detection technique for distinguishing repong damar cover from surrounding natural forests, and
- To analyze changes in Repong Damar coverage in West Coast of Lampung since 1990 to 2018
- To develop Forest Reference Emission Level in Repong Damar

Benefits of Research :

- This research is expected to contribute information to science, especially vegetation / agroforestry detection techniques.

Data Analysis:

Repong Damar Detection Method

- *Supervised Classification*
 - *Maximum Likelihood Classification*
- *Object Oriented Classification*
 - *Nearest Neighbor Classification*
- *Vegetation indices*
 - *Enhanced Vegetation Index*
 - *Normalized Difference Vegetation Index*
 - *Normalized Difference Water Index*

Changes Repong Damar Cover

- Image analysis in 1990, 1993, 2000, 2006, 2009, 2015 dan 2018 using the best method

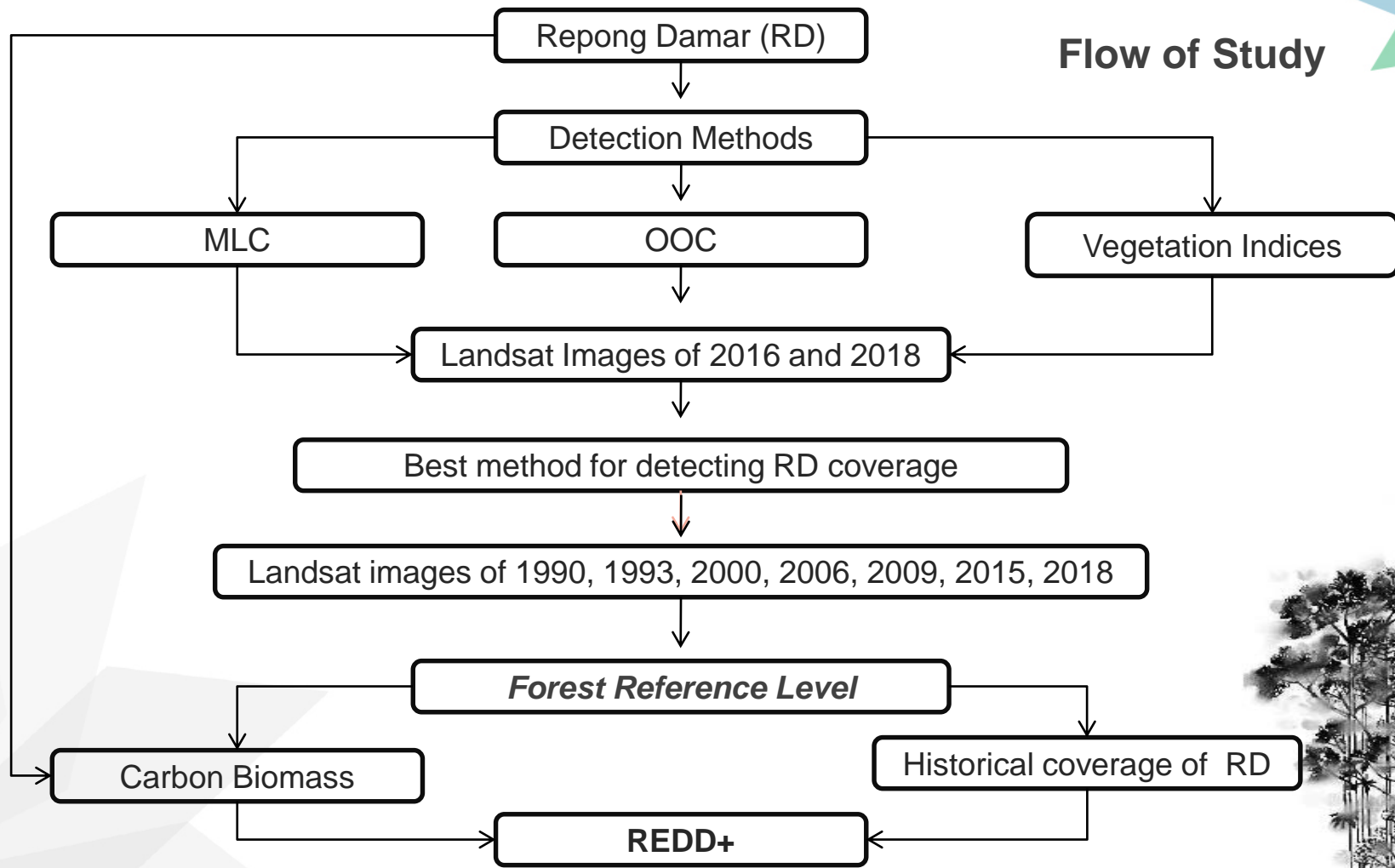
Estimates of GHG Emissions from Repong Damar

- History Repong Damar cover area
- Biomass Repong Damar
- Emission analysis of Repong Damar

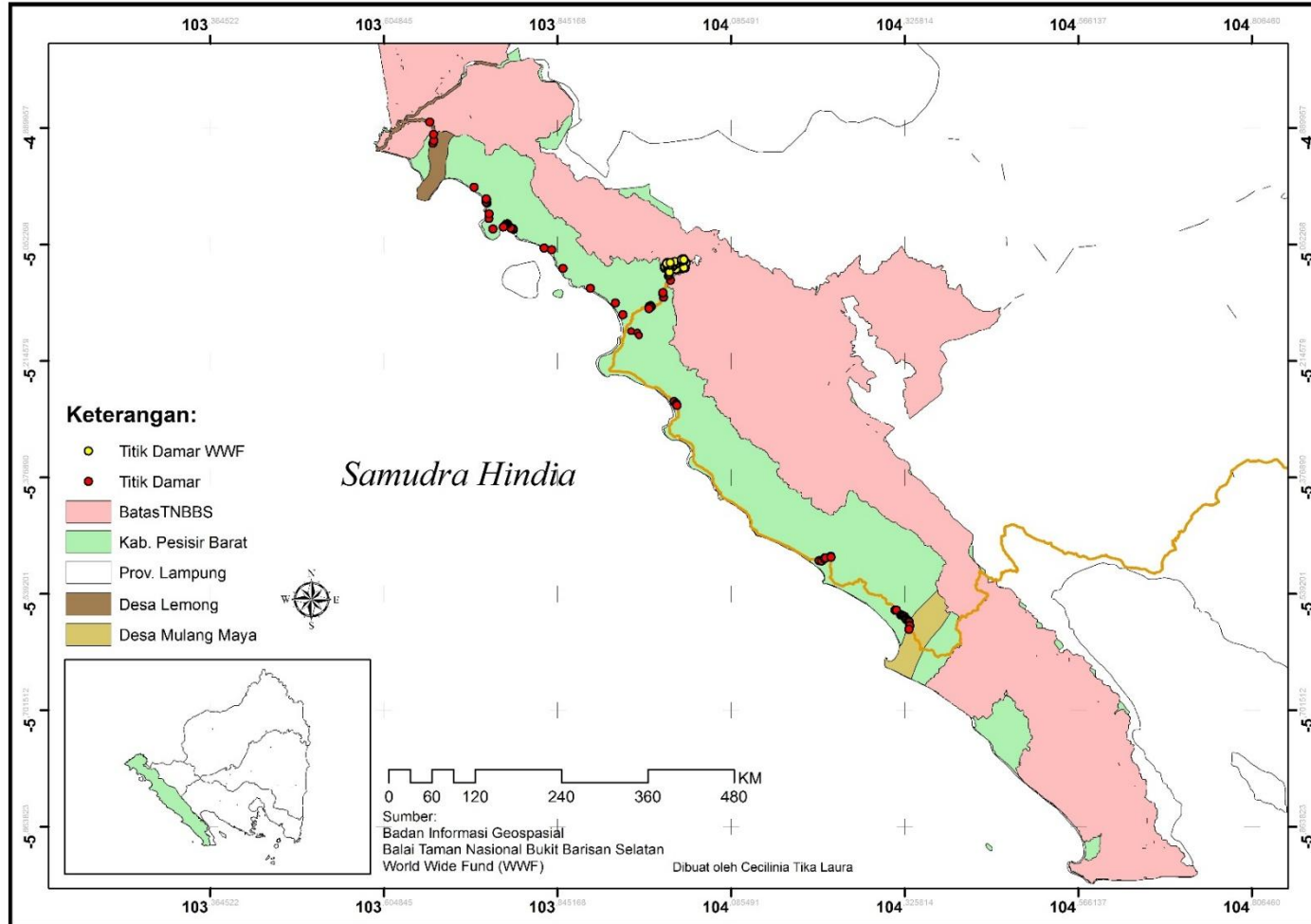




Flow of Study

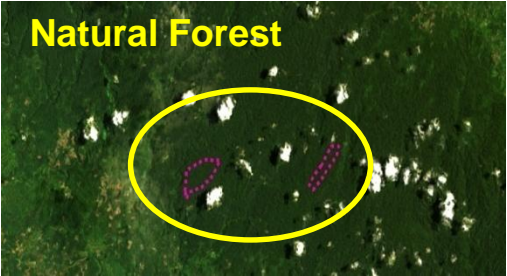
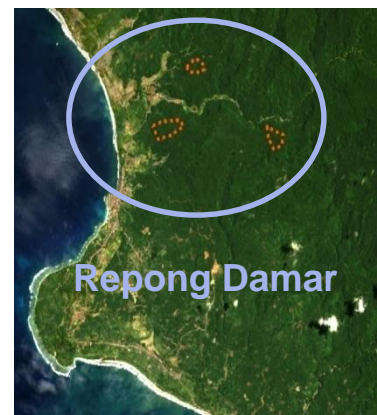


MAP OF FIELD ORIENTATION RESULTS IN 2018





VEGETATION INDICES DETECTION METHOD



Classification Sample Class
(EVI, NDVI, NDWI)
of 2016 and 2018

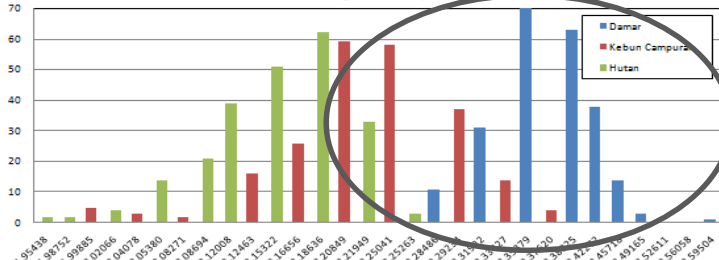
Types of Image	Sample Class	Year	Index Value					
			EVI		NDVI		NDWI	
			Min	Mak	Min	Mak	Min	Mak
Landsat Image	Repong Damar	2016	2,25039	2,59504	0,87039	0,94478	-0,87469	-0,78801
		2018	2,21814	2,56124	0,85364	0,91471	-0,84894	-0,76747
	Natural Forest	2016	1,92124	2,25263	0,87508	0,93413	-0,86975	-0,81140
		2018	1,73891	2,42830	0,81072	0,91210	-0,84772	-0,74656
	Mixed Garden	2016	1,95693	2,37620	0,85123	0,93065	-0,85823	-0,76713
		2018	1,80691	2,56381	0,76942	0,90100	-0,82461	-0,71821



Histogram Graph Vegetation Index Value

2016

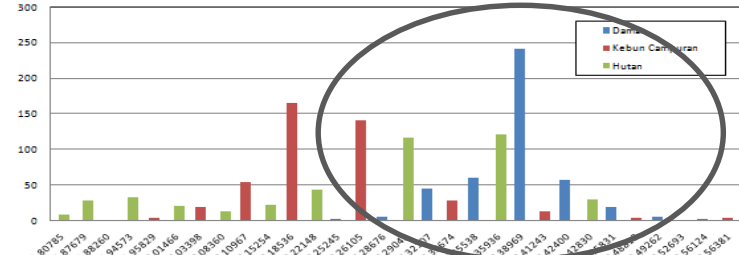
Enhanced Vegetation Index (EVI) Value



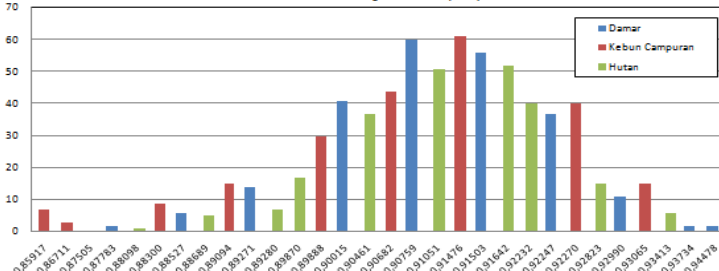
EVI

2018

Enhanced Vegetation Index (EVI) Value

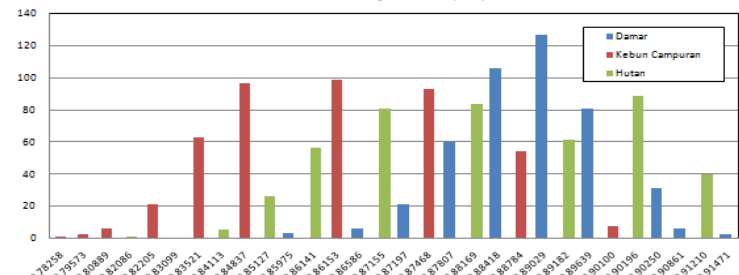


Normalized Difference Vegetation Index (NDVI) Value

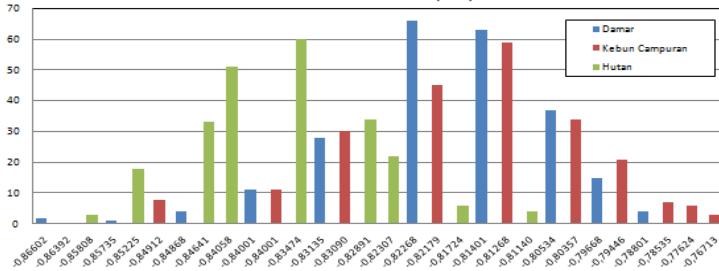


NDVI

Normalized Difference Vegetation Index (NDVI) Value

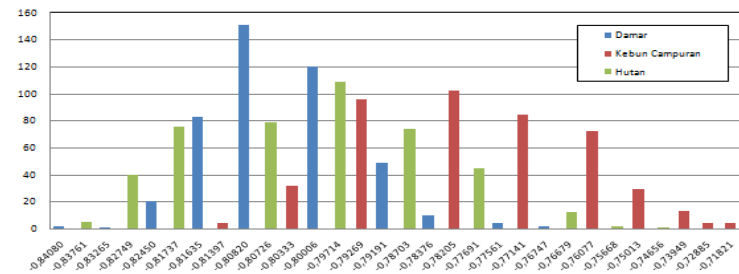


Normalized Difference Water Index (NDWI) Value

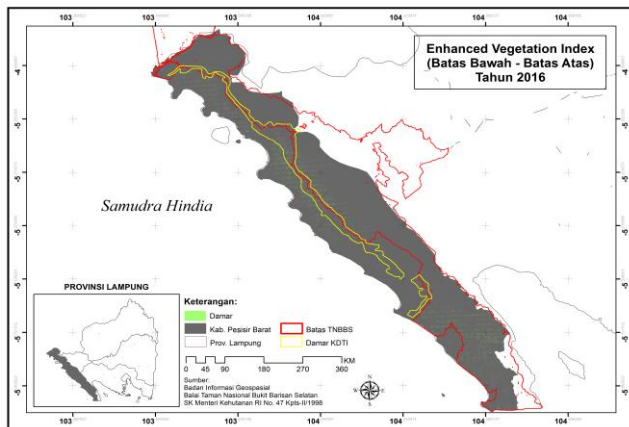


NDWI

Normalized Difference Water Index (NDWI) Value



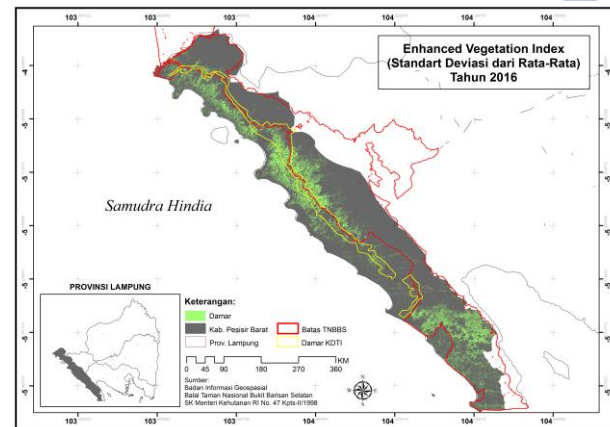
Peta Hasil Metode Deteksi *Enhanced Vegetation Index*



Upper Limit – Lower Limit

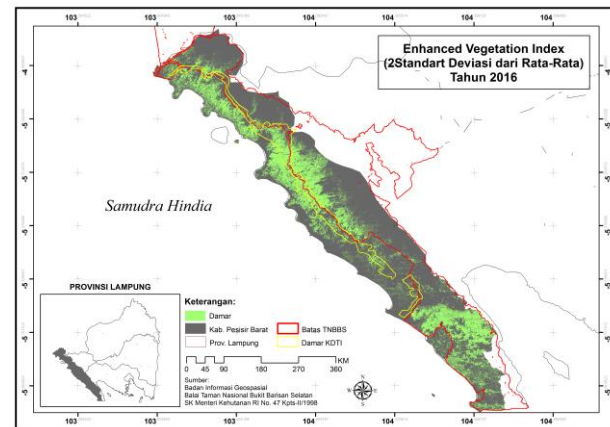
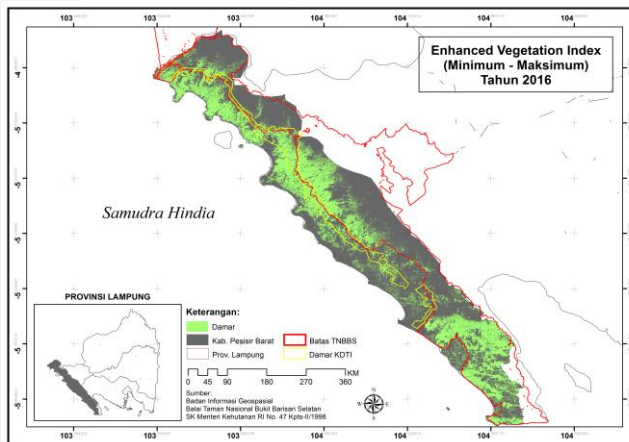
Standard Deviation from Mean

2016



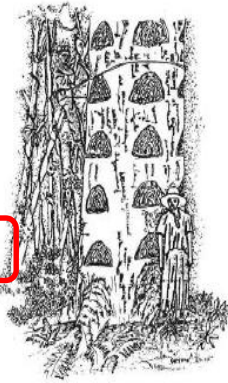
Minimum - Maksimum

2Standard Deviation from Mean

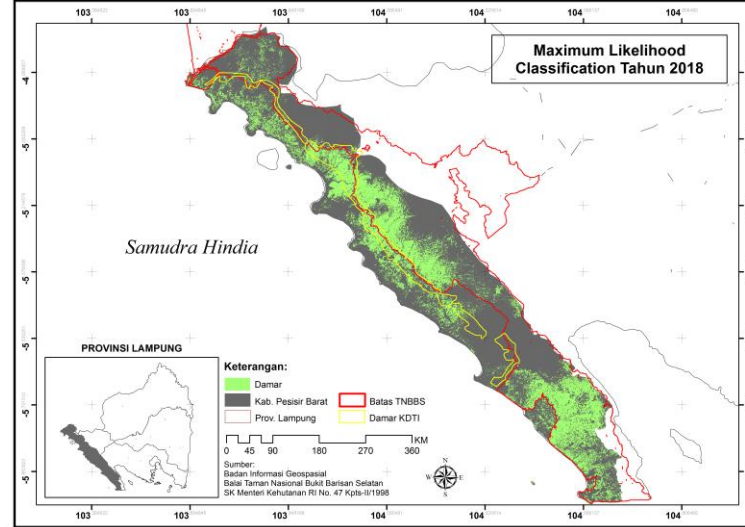
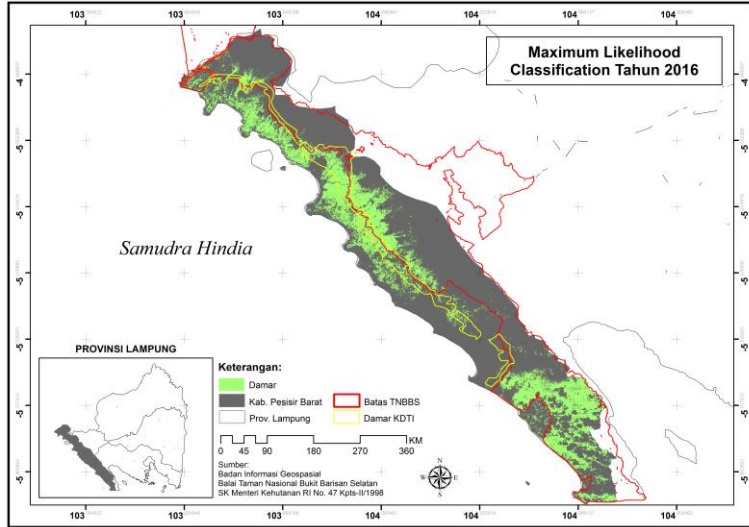


Accuracy Assessment of Enhanced Vegetation Index

No	Year	Method	Threshold	Accuracy		
				Overall	Producer (Damar)	User (Damar)
1	2016	EVI	Upper Limit – Lower Limit	55,48%	90%	12,19%
			Minimum – Maksimum	74,69%	32,22%	94,03%
			Standard Deviation from Mean	75,51%	82,41%	64,76%
			2*Standard Deviation from Mean	77,81%	72,04%	90,78%
2	2018	EVI	Upper Limit – Lower Limit	53,33%	83,33%	8,33%
			Minimum – Maksimum	75,50%	67,19%	99,66%
			Standard Deviation from Mean	76,66%	81,74%	68,66%
			2*Standard Deviation from Mean	83,33%	78,40%	92%



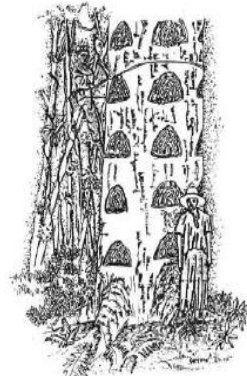
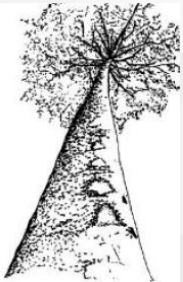
Maximum Likelihood Classification Method



- Sample Class :
1. Water Body
 2. Natural Forest
 3. Repong Damar
 4. Mixed Garden
 5. Thicked
 6. Land Use
 7. Cloud
 8. Cloud Shadow

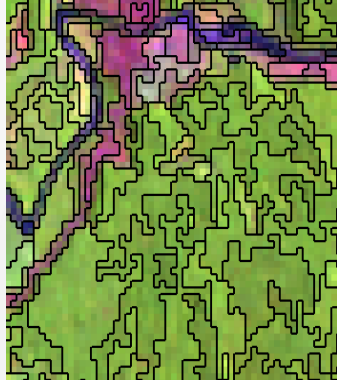
Value of Accuracy

No	Year	Method	Value of Accuracy		
			Overall	Prosedur (Damar)	User (Damar)
1	2016	MLC	75%	48,29%	71%
2	2018		92,16%	90,13%	67%

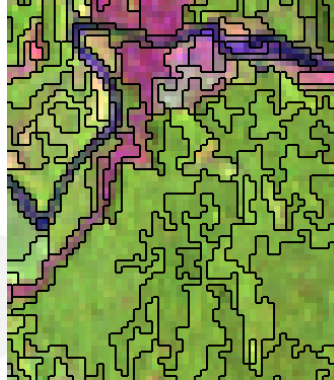


OBJECT ORIENTED CLASSIFICATION METHOD

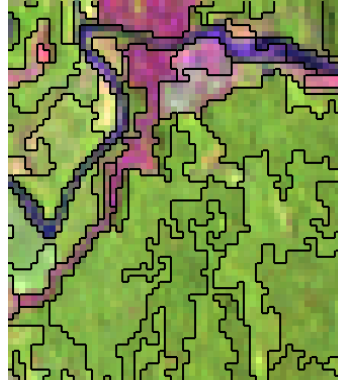
Types of Image	Research Area	Year	Parameter		
			Scale	Shape	Kekompakan
Landsat Image	West Coast District, Lampung Province	2016	25	0,1	0,5
			30	0,1	0,5
			50	0,1	0,5
		2018	25	0,1	0,5
			30	0,1	0,5
			50	0,1	0,5



Segmentation 25



Segmentation 30

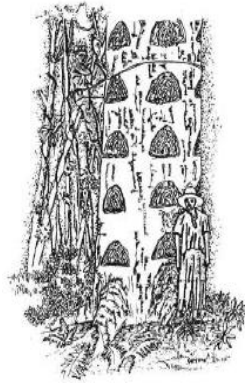


Segmentation 50

Segmentation and Sample Taking

Sample Class :

1. Water Body
2. Natural Forest
3. Repong Damar
4. Mixed Garden
5. Thicked
6. Land Use
7. Cloud
8. Cloud Shadow



Accuracy Assessment of Object Oriented Classification Method

No	Year	Method	Value of Accuracy		
			Overall	Producer (Damar)	User (Damar)
1	2016	Segmentation 25	71,72%	68,88%	62,00%
		Segmentation 30	73,38%	75,84%	59,66%
		Segmentation 50	72,55%	69,45%	63,66%
2	2018	Segmentation 25	90,83%	79,83%	66,00%
		Segmentation 30	89,72%	72,98%	69,33%
		Segmentation 50	92,27%	74,67%	91,42%

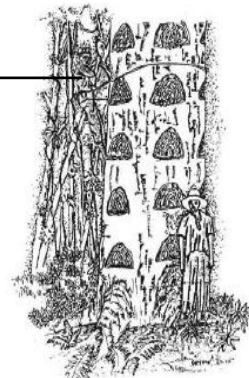
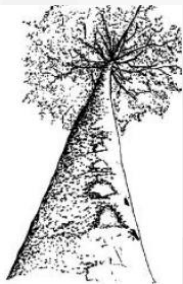
The Overall Accuracy Value of The Repong Damar Detection Method



No	Method	Value of Accuracy		
		Overall	Producer (Damar)	User (Damar)
1	OOO	92,27%	74,67	91,42%
2	MLC	92,16%	90,13%	67%
3	Vegetation Index (EVI) 2Standard Deviation from Mean	83,33%	78,40%	92%

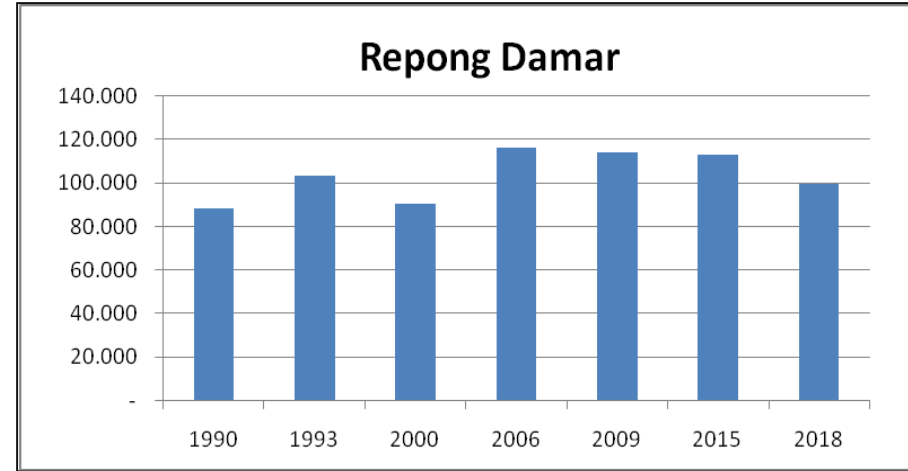
Conclusion:

1. The best method for detecting the distribution of Repong Damar is the OOO method with an accuracy value of 92.27%



REPONG DAMAR COVER CHANGE

No	Year	Repong Damar
		Area (ha)
1	1990	88,307
2	1993	103,581
3	2000	90,864
4	2006	116,146
5	2009	114,297
6	2015	112,991
7	2018	99,693



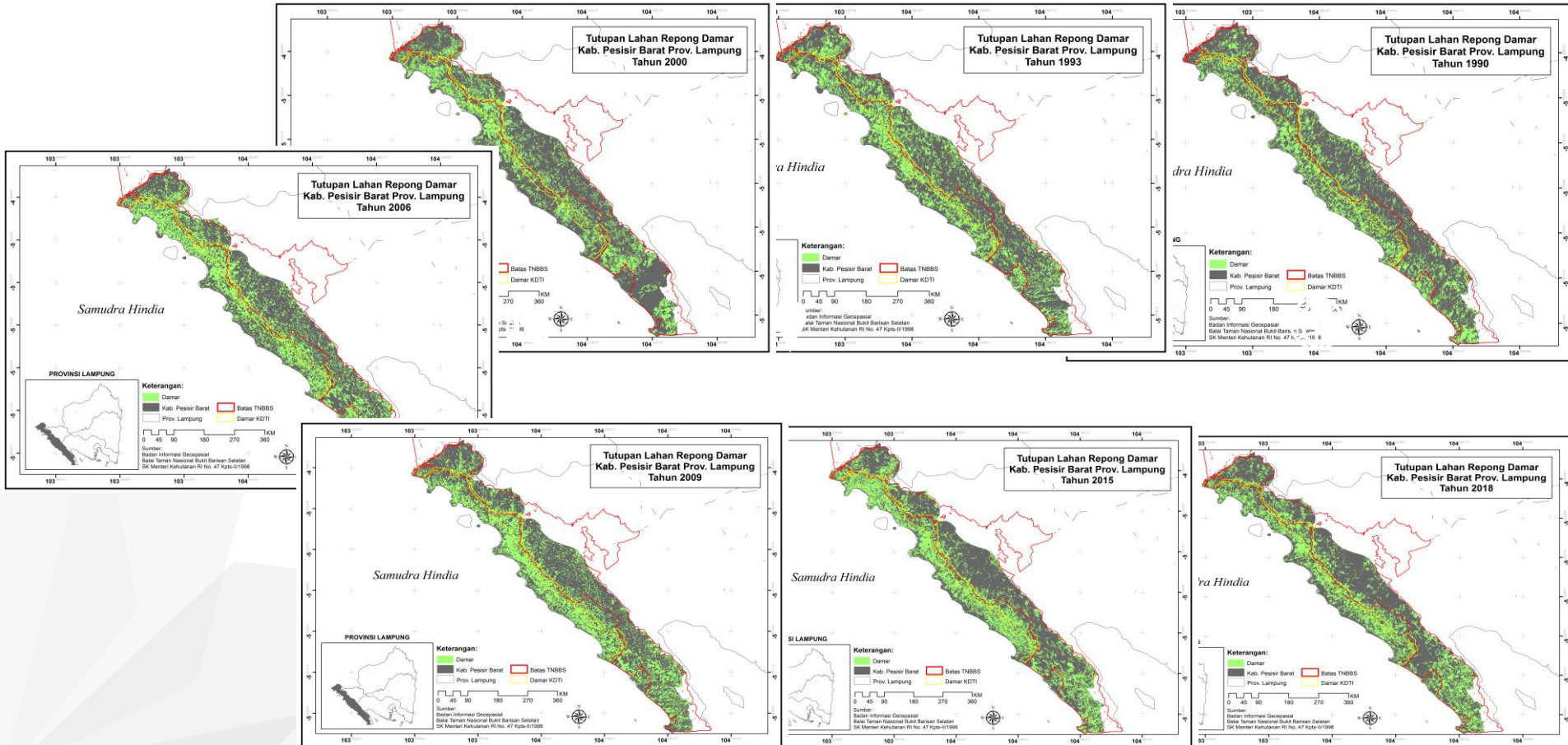
No	Year	Values of Accuracy		
		Overall	Producer (Damar)	User (Damar)
1	1990	81%	60.82%	79%
2	1993	81.07%	63.27%	79%
3	2000	86.33%	79.93%	83.67%
4	2006	89.67%	75%	87%
5	2009	89.27%	74.04%	90.33%
6	2015	93.80%	82.68%	92.33%
7	2018	93.27%	91.42%	74.67%

Conclusion:

2. The area of Repong Damar has been increased and decreased. The last area of repong damar (2018) is 99,693 ha.



Map of Repong Damar Cover Changes

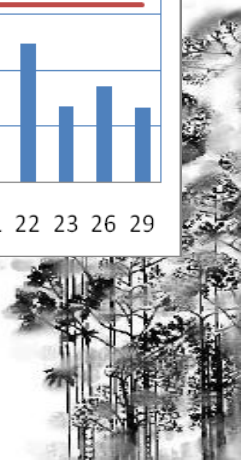
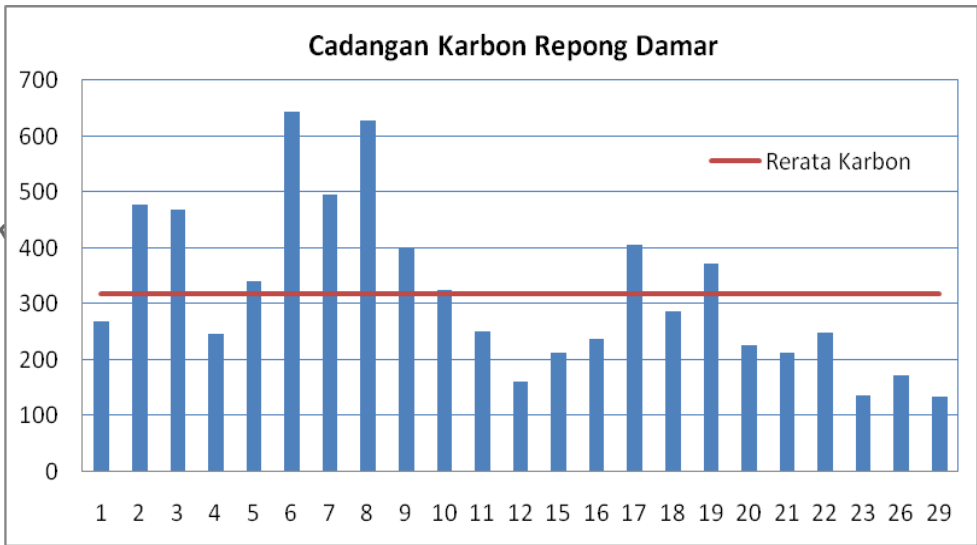




Repong Damar Carbon Stock

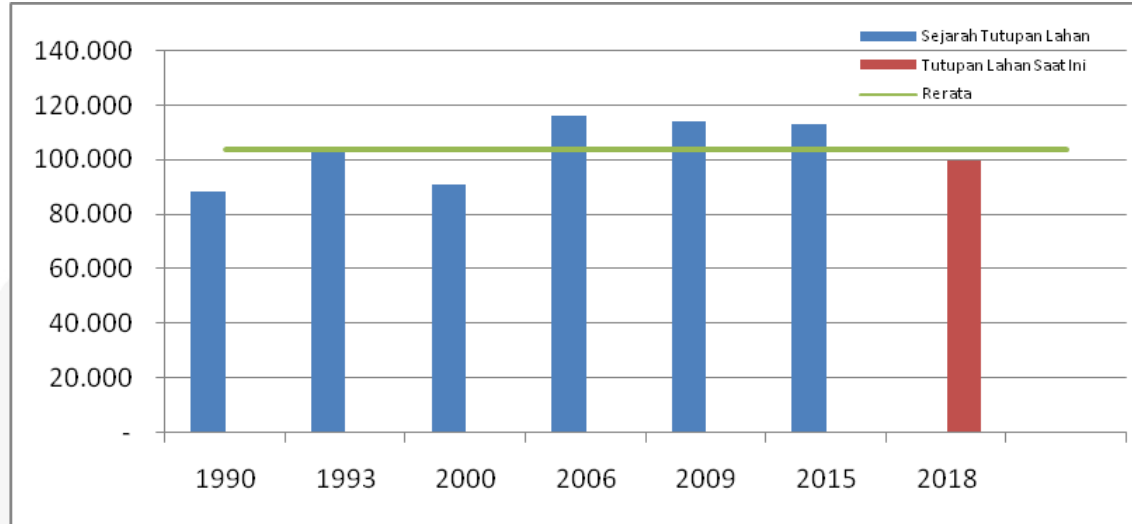
No Plot	Carbon Stock (t/ha)
1	267,43
2	476,90
3	467,19
4	244,31
5	338,88
6	643,99
7	494,92
8	627,04
9	401,33
10	323,10
11	249,70
12	160,65
15	210,65
16	235,55
17	404,27
18	285,37
19	370,30
20	225,12
21	210,55
22	247,75
23	134,82
26	170,88
29	132,47
Average	318,40

The Value of Stock
Carbon (t/ha) of
Each Plot



Estimated Emissions Levels of Repong Damar

Forest Reference Level (FRL)



Average Change in Repong Damar:
In 1990 – 2015 = 104,364 ha

Area in 2018 = 99,693 ha

History of the area Repong Damar



Repong Damar Emission Level Reference Produced

	Cover of Repong Damar (Ha)	Repong Damar Carbon Average (tC/ha)	Total (tC)
In 2018	99.693	318	31.702.374
FRL	104.364	318	33.187.858
Performance			-1.485.484

If the value (-) is negatif = emit
If the value (+) is positif = absorb



CONCLUSION

- The most accurate method for detecting the distribution of Repong Damar is the object-based detection method (Object Oriented Classification) with an accuracy value of 92.27%.
- The area of Repong Damar from 1990 to 2018 has experienced addition and reduction.
- The last area of Repong Damar in 2018 was 99,693 ha, spread from Mulang Maya Village, Bengkunt Subdistrict to Lemong Village, Lemong Subdistrict
- FREL Repong Damar cannot be built because Repong Damar is Deforested and Reforested. The replacement for FREL is FRL, because the FRL pays attention to the ability of Repong Damar to absorb carbon.

Monitoring Agroforestry for REDD+ Implementation using Remote Sensing Data and Geographic Information System: a Case Study of Repong Damar, Pesisir Barat Lampung



Corresponding Author:
Cecilia Tika Laura
ceciliniatikalaura16@gmail.com

Jurusan Kehutanan, Universitas Lampung, Jl. Sumantri Brojonegoro No.1 Bandar Lampung