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Research Article

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Mapping of Mangrove Ecosystem In Segara Anakan Lagoon using Normalized Different Vegetation Index and Dominant Vegetation Index

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ABSTRACT

Mangrove ecosystem in Segara Anakan Lagoon (SAL) Cilacap as a typical and specific semiclosed estuary. SAL is dominated by many species like as *Rhizophora* spp., *Sonneratia* spp., *Bruguiera* spp., *Avicennia* spp., and other species. The normalized different vegetation index (NDVI) and dominant vegetation index (DVI) are a suitable method to support the mapping analysis of mangrove structure and mangrove density. This research aimed to develop mapping of mangrove species distribution, density and dominated species using NDVI and DVI. The method of this research used NDVI analysis using satellite imagery 2017-2020 and domination vegetation with line and quadrat transect method. The results showed that West Segara Anakan had mangrove dense (25 %), moderate density (25 %), rare density (50%) and East Segara Anakan had mangrove dense (43,86 %), moderate density (47.99 %), rare density (8,24 %). Based on domination species showed that East Segara Anakan was dominated by *Rhizophora stylosa* (233-1633 trees ha^{-1}), *Rhizophora apiculata* (100-1067 trees ha^{-1}), *Nypa frutican* (50-2775 trees ha^{-1}), whereas West Segara Anakan was dominated by *Nypa frutican* (565-2333 trees ha^{-1}), *Avicennia marina* (198-933 trees ha^{-1}), *Sonneratia caseolaris* (132-700 trees ha^{-1}) and *Avicennia alba* (107-1000 trees ha^{-1}).

Keywords: *Mangrove density, mapping analysis, Segara Anakan Lagoon, NDVI and NDWI*

ABSTRAK

Mangrove di Segara Anakan Cilacap merupakan suatu ekosistem estuary yang semi tertutup dan diomniasi oleh *Rhizophora* spp*., Sonneratia* spp*., Bruguiera* spp*., Avicennia* spp., dan beberapa jenis manrove lainnya. NDVI (*normalized different vegetation index*) dan indeks vegetasi dominan (INP) adalah metode yang cocok untuk mendukung analisis pemetaan struktur mangrove dan kerapatan mangrove. Penelitian ini bertujuan untuk mengembangkan pemetaan sebaran, kerapatan, dan dominasi jenis mangrove dengan menggunakan NDVI dan DVI. Metode yang digunakan adalah analisis NVDI dan analisis vegetasi (INP) dengan menggunakan citra satelit 2019-2020. Hasil penelitian menunjukan bahwa Segara Anakan Barat memiliki mangrove rapat 25 %), kerapatan sedang (25 %), kerapatan jarang (50%), sedangkan Segara Anakan Timur memiliki mangrove rapat (43,86 %), kerapatan sedang (47.99 %), kerapatan jarang (8,24 %). Berdasarkan tingkat dominansi menunjukan bahwa Segara Anakan Tmur didominasi oleh jenis *Rhizophora stylosa* (233-1633 pohon/ha), *Rhizophora apiculata* (100-1067 pohon/ha), *Nypa frutican* (50-2775 pohon/ha), Sedangkan Segara Anakan Barat didominasi oleh *Nypa frutican* (565-2333 pohon/ha), *Avicennia marina* (198-933 pohon/ha), *Sonneratia caseolaris* (132-700 pohon/ha) dan *Avicennia alba* (107-1000 pohon/ha).

Kata kunci: Kerapatan mangrove, analisis pemetaan, Laguna Segara Anakan, NDVI dan NDWI

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1. Introduction

Segara Anakan Lagoon Cilacap as semiclosed estuary ecosystem is dominated by various ecosystems, including lagoon and mangrove ecosystems (Hilmi et al., 2015, 2021b; Sari et al., 2016; Hilmi 2018). The lagoon and mangrove ecosystem in Segara Anakan are influenced by oceanographic factors like as tides and water depth (Cahyo 2012; Hilmi et al., 2019c, 2021a), sedimentation (Sari et al., 2016), pollution levels (Hidayati et al., 2011; Hilmi et al., 2015), organism recovery (Syakti et al., 2013b; Hilmi et al., 2021d, 2022b), and anthropogenic factors (Giri et al., 2015; Liu et al., 2020). In addition, the supply of fresh water supply from the Citanduy River, Cibeureum River, Cikonde River and Palindukan River in the West Segara Anakan (Ardli & Wolff 2008; Sari et al., 2016; Hilmi et al., 2021a) and the Donan River, Sapuregel River, Kembang Kuning River, and Dangal River in the east (Hidayati et al., 2014; Hilmi et al., 2021e, d) give affect for the existence, distribution and density level of mangrove ecosystem.

The distribution of mangrove domination, structure and density in Segara Anakan will be shown by the affinity of the mangrove vegetation to develop associations and species clusters (Hilmi et al., 2021d), vertical and horizontal structural patterns (Azman et al., 2021), adaptation patterns and species reference ecology (Rougier et al., 2005; Markle and Chow-Fraser 2016), adaptation of sedimentation (Li et al., 2016; Bullock et al., 2017; Youcef & Amira 2017), waterlogging (Hilmi et al., 2017a, 2022c; Suhendra et al., 2018) and reduce pollution impact including heavy metal, hydrocarbon and pesticide pollution (Syakti et al., 2013a; Hidayati et al., 2014; Prastyo et al., 2017). The many researches show that East Segara Anakan is dominated by *Sonneratia caseolaris, Avicennia marina, Rhizophora stylosa, Nypa frutican* and *Rhizophora apiculata,* and West Segara Anakan is dominated by *Avicennia marina, Sonneratia caseolaris, Aegiceras corniculatum* and *Nypa frutican* (Hilmi et al., 2015, 2021a, c; Hilmi 2018). This results also show that mangrove vegetations in Segara Anakan have a typical adaptation pattern to live, grow and regenerate. This adaptation pattern will influence the pattern of species density, structure and distribution of mangrove vegetation. The potency of density, structure and species distribution can be explored by mapping analysis.

Mapping analysis of mangrove ecosystem (viewing the species domination, distribution and density of mangrove) can be analysed by utilizing combine among dominant vegetation index (DVI), remote sensing analysis with NDVI and geographic information systems. The mapping analysis of mangrove ecosystem in this research using Sentinel 2A imagery and Landsat 8 (2017-2020) because have a high and moderate resolution multispectral (Lee and Yeh 2009; Drusch et al., 2012). The mangrove mapping and mangrove covering using the normalized difference vegetation index (NDVI) and dominant species index (DVI) (Taufik et al., 2017; Hartoyo et al., 2021; Hilmi et al., 2021d) to analysis mangrove density, mangrove covering and mangrove degradation (Meneses-Tovar 2011; Kantharajan et al., 2018). The results of the image analysis will be contructed by overlay between the potential density of mangroves taken the transect method and satellite imagery. This research aimed to analysis mapping of mangrove species distribution, density and species dominant using NDVI and dominant vegetation index (DVI)

2. Material and Methods

2.1. Research site

This research was conducted on the mangrove ecosystem in East and West Segara Anakan Lagoon, Cilacap (**Figure 1 and Table 1**). The number of sampling stations were 37 samples distributed in West Segara Anakan (20 stations) and East Segara Anakan (17 stations) (Hilmi et al., 2021e, b).

The selection of sample plots following the distribution of mangrove species density and potential of river station in West and East of Segara Anakan lagoon. Each station has 5-8 sample plots (plot size: 10 m x 10 m) The number of stations following the rivers like as Kali Panas, Donan, Sapuregel, Kembang Kuning and Muara Pelawangan Timur (East Segara Anakan). Meanwhile, the station in West Segara Anakan is located in 15 sub rivers. Bassically Segara Anakan Lagoon has 4 main rivers that are Citanduy River, Cikonde River, Cibeureum River and Donan River (Hilmi et al., 2015, 2019c).

2.2. Sampling Technique

The research used forest and ecology inventory methods (line and quadrat transect methods) following cluster random sampling based on river conditions and mangrove density (Khadim et al., 2019; Hilmi et al., 2021b, e). The

Table 1. Research stations (sources : Hilmi et al., 2021c)

Stations(station for what)/Sampling points?	**Coordinate**		**Stations**	**Coordinate**	
	Latitude (S)	**Longitude (E)**		**Latitude (S)**	**Latitude (S)**
West Segara Anakan			**East Segara Anakan**		
Ujung Gagak river	07◦40'13"	108◦48'43"	Kali Panas 1 river	07^{0} 40’ 22,17”	109^{0} 0’ 56,36”
Lorogan river	07◦40'44"	108◦48'30"	Kali Panas 2 river	07^{0} 40’ 28,91”	109^{0} 0’ 40,57”
Majingklak river	07◦40'32"	108◦48'1"	Kali Panas 3 river	07^{0} 40’ 20,60”	109^{0} 0’ 33,62”
Mauara Cawitali river	07◦41'46"	108◦47'41"	Kali Panas 4 river	07^{0} 40’ 18,26”	109^{0} 0’ 32,52”
Kebuyutan river	07◦41'13"	108◦47'45"	Kali Panas 5 river	07^{0} 40’ 41,12”	109^{0} 0’ 33,98”
Batu Macan river	07◦41'38"	108◦47'46"	Donan 1 river	07^{0} 40’ 33,98”	108^{0} 59’ 58,10”
Jongor river	07◦40'23"	108◦48'20"	Donan 2 river	07^{0} 40’ 23,79”	108^{0} 59’ 56,90”
Muara Legok river	07◦39'48"	108◦48'13"	Donan 3 river	07^{0} 41’ 15,49”	108^{0} 59’ 43,22”
Kayu Mati river	07◦39'5"	108◦48'27"	Donan 4 river	07^{0} 42’ 10,17”	108^{0} 59’ 23,75”
Langkap river	07◦38'48"	108◦48'44"	Donan 5 river	07^{0} 42’ 46,06”	108^{0} 59’ 29,10”
Karang Braja river	07◦40'59"	108◦48'47"	Donan 6 (Sleko) river	07^{0} 43’ 48,07”	108^{0} 59’ 10,78”
Klaces river	07◦41'5"	108◦49'47"	Pelawangan Timur	07^{0} 43’ 20,95”	108^{0} 58’ 07,45”
Inti Ujung Gagak river	07◦40'34"	108◦49'47"	Sapuregel 1 river	07^{0} 41’ 53,33”	108^{0} 57’ 46,71”
Muara Bagian river	07◦40'58"	108◦51'42"	Sapuregel 2 river	07^{0} 41’ 47,97”	108^{0} 57’ 37,81”
Muara Masigitsela river	07◦41'24"	108◦50'46"	Sapuregel 3 river	07^{0} 42’ 54,20”	108^{0} 57’ 42,07”
Ujung Alang junction	07◦41'44	108◦51'39"	Kembang Kuning1 river	07^{0} 43’ 12,88”	108^{0} 57’ 14,24”
Ujung Alang	07◦42'0"	108◦51'42"	Kembang Kuning2 river	07^{0} 43’ 07,52”	108^{0} 57’ 03,97”
Ujung Alang port	07◦42'6"	108◦51'53"			
Kali Semak river	07◦42'30"	108◦52'57"			
Sudiro junction	07◦42'32"	108◦53'38"			

sampling technique divided research location into 37 stations (**Figure 2 and Table 1**). The research station represent the mangrove species density and coverage of mangrove area to support result of NDVI Index.

2.3. Vegetation Analysis

The vegetation samples for each sampling plot were collected using a 10 m x 10 m transect with 3 replications (Kusmana et al., 2005; Hilmi et al., 2019b, 2021d) **(Figure 2).** For each sampling plot was measured the number of mangrove species, the number of mangrove tress, Diameter at Breast Height (DBH) (for mangrove diameter > 4 cm)) (Hilmi et al., 2020) After mangrove inventory using line and quadrat transect, the mangrove density will be by equation:

$$\boldsymbol{mangrove\ density} = \frac{\textit{the number of individual for mangrove trees}}{\textit{area of sampling plot}}$$

(Kusmana et al., 2005; Dangan-Galon et al., 2016; Hilmi et al., 2020)

The classification of mangrove density could be shown **Table 2**. The classification of mangrove density using the mangrove with diameter > 4 cm. The mangrove density was

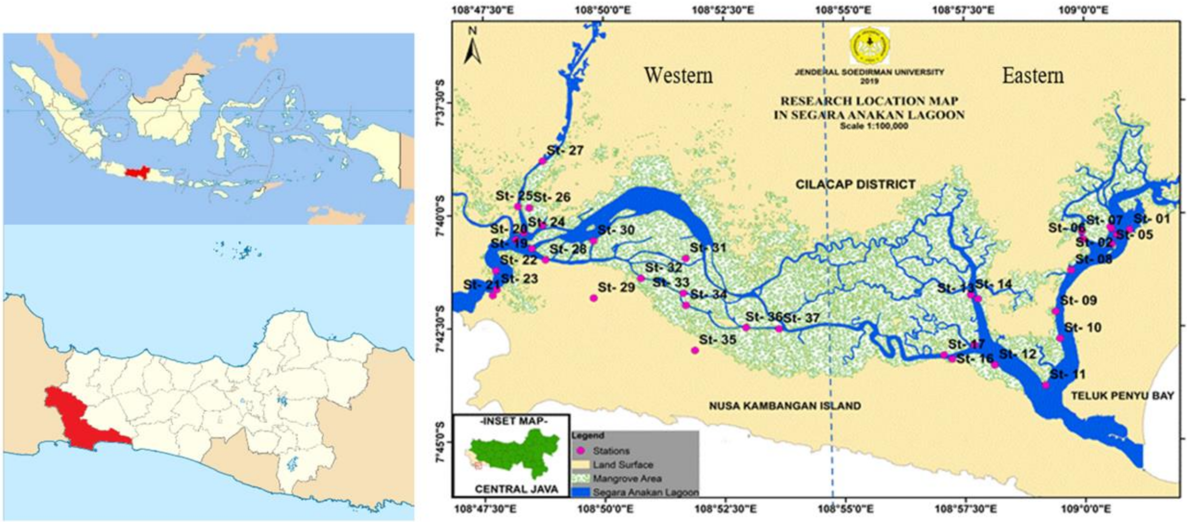

Figure 1. Study area in Segara Anakan Lagoon, Cilacap District, Central Java, Indonesia (sources: (Hilmi et al., 2021a))

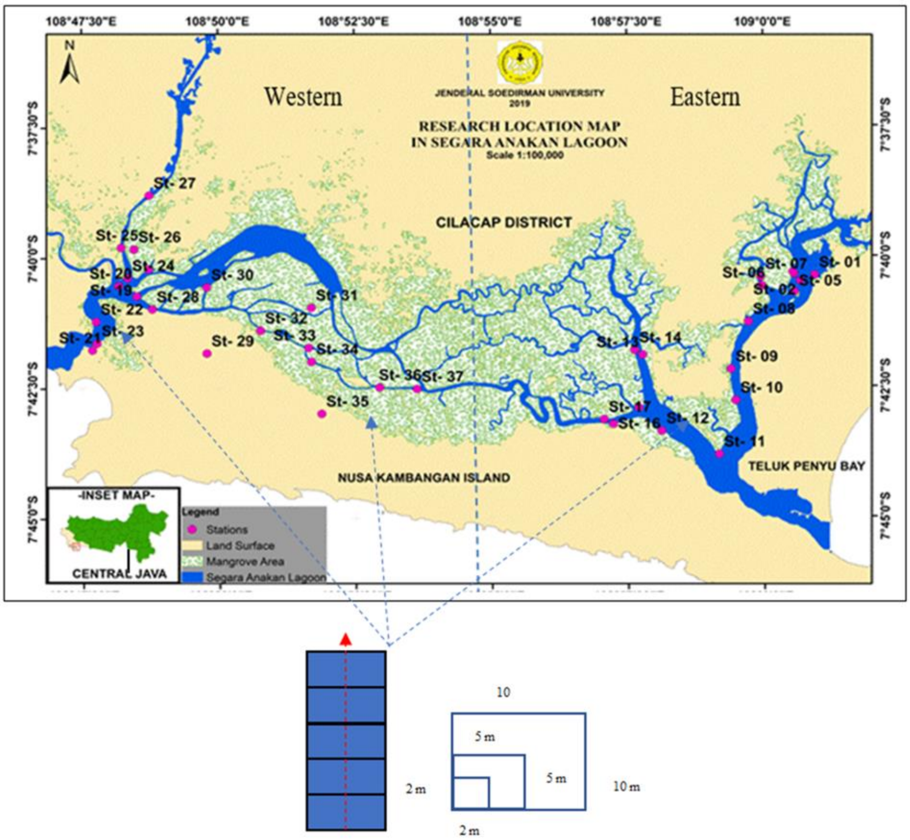

Figure 2. Line Transect

divided into 5 classes that were very rare density, rare, moderate, dense and very dense (Hilmi, et al., 2019a)

2.4. Dominant Vegetation Index (DVI)

DVI was calculated by domination relative (DR), density relative (KR) and frequency relative (FR) (Hilmi *et al.,* 2019). DVI had equation = DR + KR + FR. The score of DVI is used to analysis domination class of mangrove species in Segara Anakan Lagoon. The mangrove domination were divided into 3 classes that were dominant (if DVI = 200-300), co-dominant or moderate (if DVI = 100-200),

Table 2. The classification of mangrove density (Hilmi *et al.,* 2019a)

Mangrove density classification	Mangrove density (trees/ha)	
	Minimum	Maximum
Very rare	0	390
Rare	391	1610
Moderate	1611	2220
Dense	2221	3137
Very dense		> 3137

minor/recessive (if DVI <100) (Hilmi et al., 2015; 2019a; 2021b).

2.5. Mapping analysis

The mapping analysis was analyzed using satellite imagery using Landsat 8 and Sentinel 2 (2017-2020). The steps analysis of Landsat 8 and Sentinel 2 were (a) image cutting, (b) masking or separation of land and water using NDWI (normalized difference water index*).* NDWI is an algorithm used to distinguish between land and water areas, also removes noise in satellite imagery, including building color contrast in the image. The NDWI algorithm uses color sensor analysis based on the green band and infrared band which were entered into the algorithm equation. The equation of algoritma was $\boldsymbol{NDWI} = \frac{\text{Green}-\text{NIR}}{\text{Green}+\text{NIR}}$, where Green : band green (Band 2 pada Landsat 7) and NIR : band near infrared (Band 4 pada landsat 7) (c) separation between mangrove and non-mangrove with an unsupervised classification approach with a maximum approach likelihood. (d) calculation of mangrove area. (e) calculation of mangrove density using NDVI (f) the analysis of area of mangrove ecosystem base on the mangrove density using leaf area index (LAI) quantifies as the amount of leaf material in a canopy (Saleh 2007; Lee and Yeh 2009; Al-Nasrawi et al., 2016).

The calculation of mangrove density can be done by the normalized difference vegetation index (NDVI) which aims to determine the level of mangrove canopy density. The NDVI formula is based on the reflectance of remotely sensed objects in the red and near infrared spectrum channels. The NDVI value has a range of values from -1 to 1. The formula for the normalized difference vegetation index (NDVI) following (Jhonnerie et al., 2015; Gizachew et al., 2016; Sari & Rosalina 2016) that was:

NDVI = (NIR-RED)/(NIR+RED)

Note :
NIR : band near infrared (canal 8 of Sentinel 2A).
RED : band red (canal 4 of Sentinel 2A)

3. Results and Discussion

3.1. Mangrove density in Segara Anakan Lagoon (SAL) Cilacap

The density of mangrove species in West Segara Anakan and East Segara Anakan could be seen in the **Table 3** and **Figure 3**. The data in the **Table 3** and **Figure 3** showed that mangroves were divided into dominant, moderate and minor or recessive mangroves. In the West Segara Anakan*, Sonneratia alba, Avicennia marina,* and *Nypa frutican* were dominant species. However mangrove ecosystem in East Segara Anakan were dominated by *Sonneratia alba, Rhizophora stylosa, Rhizophora apiculata, Avicennia marina, Aegiceras corniculatum* and *Nypa frutican*.

Based on data in **Table 2** explained that mangrove in SAL was divided into 3 classes, that were minor species,co-dominant species.and dominant species The minor species were dominated by *Aegiceras floridum, Avicennia alba, Avicennia officinalis, Ceriops tagal, Ceriops decandra, Bruguiera sexangular, Bruguiera parviflora, Sonneratia caseolaris, Xylocarpus granatum, Xylocarpus moluccensis*. The co-dominant species (moderate density) were dominated *by Bruguiera gymnorrizha, Rhizophora mucronata* and *Aegiceras corniculatum.* While the dominant species were dominanted by *Sonneratia alba, Rhizophora stylosa, Rhizophora apiculata, Avicennia marina, Aegiceras corniculatum* and *Nypa frutican.*

The data in the **Figure 3** also explained the combination between dominant mangrove species in SAL. The combination between species dominant of mangrove vegetation in Segara Anakan showed that *Aegiceras corniculatum* with *Avicennia marina, Aegiceras corniculatum* with *Nypa fruticans, Aegiceras corniculatum* with *Rhizophora apiculata, Aegiceras corniculatum* with *Rhizophora mucronata, Avicennia marina* with *Rhizophora mucronata, Avicennia marina* with *Rhzophora stylosa, Rhizophora apiculata* with *Aegiceras corniculatum, Rhizophora apiculata* with *Nypa frutican, Rhizophora mucronata with Nypa frutican* until *Xylocarpus granatum* with *Nypa frutican.* The combination of mangrove species

Table 3 . Mangrove Density in Segara Anakan Lagoon

mangrove species	Density (tree/ha) West		mangrove species	Density (tree/ha) East	
	Interval	domination Class		Interval	domination Class
Aegiceras floridum	100-200	recessive/minor	*Aegiceras corniculatum*	25-1280	dominant
Aegiceras corniculatum	100-467	recessive/minor	*Avicennia alba*	67-500	recessive/minor
Avicennia alba	33-100	recessive/minor	*Avicennia marina*	33-1400	dominant
Avicennia marina	33-1020	dominant	*Bruguiera gymnorrhiza*	33-867	moderate
Avicennia officinalis	100-333	recessive/minor	*Bruguiera praviflora*	60-62	recessive/minor
Bruguiera gymnorrhiza	33-700	moderate	*Bruguiera sexangula*	33-300	recessive/minor
Ceriops tagal	33-267	recessive/minor	*Ceriops decandra*	67-420	recessive/minor
Nypa frutican	100-2333	dominant	*Ceriops tagal*	167-180	recessive/minor
Rhizophora apiculata	133-233	recessive/minor	*Excoecaria agallocha*	50-200	recessive/minor
Rhizophora mucronata	33-767	moderate	*Heritiera littoralis*	100-250	recessive/minor
Rhizophora stylosa	67-233	recessive/minor	*Nypa frutican*	50-2775	dominant
Sonneratia alba	33-1133	dominant	*Rhizophora apiculata*	100-1067	dominant
Sonneratia caseolaris	33-700	moderate	*Rhizophora mucronata*	33-767	moderate
Xylocarpus granatum	33-700	moderate	*Rhizophora stylosa*	67-1633	dominant
Xylocarpus moluccensis	67-200	recessive/minor	*Sonneratia alba*	25-1900	dominant
			Sonneratia caseolaris	33-100	recessive/minor
			Xylocarpus granatum	150-250	recessive/minor
			Xylocarpus moluccensis	50-150	recessive/minor

showed that the domination relation between mangrove species in Segara Anakan Lagoon (Hilmi et al., 2015, 2021d; Pham et al., 2019).

The distribution of species density of mangrove ecosystem in SAL showed the spatial distribution of mangrove density for each species and mangrove area (Hilmi et al., 2015, 2017b, 2021d; Sari et al., 2016). Species density also is indicated by the number of individuals for sampling plot area (trees ha^{-1}). Species density give impact for the structure, composition, growth and species sustainability in the ecosystem (Njana, 2020), productivity and sustainable yield (Njana, 2020), diversity and heterogeneity (Owuor et al., 2019; Dencer-Brown et al., 2020). Basically, The density of mangrove species will be influenced by the species adaptation toward salinity, pH, texture, water quality (Hilmi et al., 2015, 2017b, 2019a; Leng and Cao 2020), the potential of pollution including heavy metals (Syakti et al., 2013a; Hilmi et al., 2017c), petroleum pollution (Syakti et al., 2013b; Ameen et al., 2016), and anthropogenic factors (Giri et al., 2015; Salampessy et al., 2015).

According to (Hilmi et al., 2021a, d) that the potential densities in East and West Segara Anakan have density between 166-4000 trees ha^{-1} and 133-3000 trees ha^{-1} respectively. The domination species of mangrove vegetation had

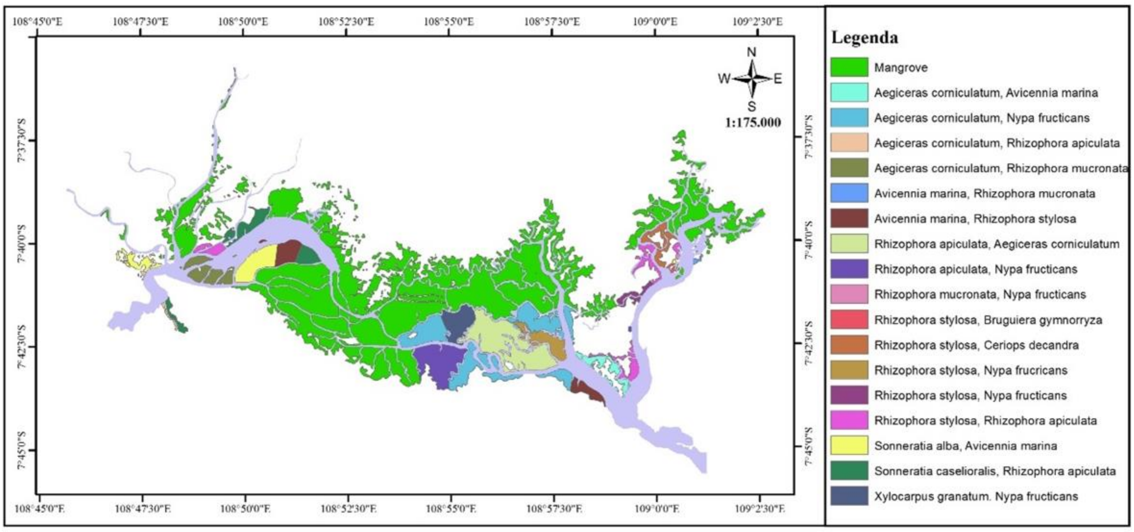

Figure 3. The domination mangrove species in Segara Anakan Cilacap

a significant difference between these regions, because had different adaptations (Hilmi et al., 2015, 2020, 2021d; Xiong et al., 2018; Khadim et al., 2019). Bassically, the species density also represent the succession, geomorphology, external disturbances, ecophysiology, and competition (Bullock et al., 2017; Fu et al., 2018; Bathmann et al., 2021) and describes pioneer species, such as *Sonneratia* spp*.,* and *Avicennia* spp., and dominant species, like as *Rhizophora* spp*., Bruguiera* spp*., Ceriops* spp*.,* and *Nypa frutican* (Umroh et al., 2016; Fu et al., 2018; Cooray et al., 2021).

3.2. The mangrove area distribution using indicators mangrove density

Utilization of high spatial resolution of satellite imagery is required to assess heterogeneous area, land cover diversity and high *resource* potential (Zhao et al., 2010; Silva et al., 2017; Andini et al., 2018). Mangrove ecosystem can be identified using remote sensing technology to analysis geographical location, mangrove density and covering area, and buffer of land and sea transition areas which provides a distinctive recording effect (Faizal & Amran 2005; Khadim et al., 2019). This technology give the spectral values of satellite images which can be extracted to analysis information of mangrove species using visible (band 2,3,4) and near-infrared (band 5) (Suwargana 2008; Gizachew et al., 2016; Santos et al., 2016).

Sari *et al.,* (2016) writes that the area of mangrove *forests* in the Segara Anakan Cilacap has decline trend every year. According to (Sari et al., 2016; Ismail et al., 2018) in 2016 the area of mangrove forest in Segara Anakan, Cilacap was 6.126,28 ha. Meanwhile, the results of the Sentinel 2A and Landsat 8 images analysis in 2019-2020, showed that the mangrove forest area in Segara Anakan Cilacap only remining 4515.13 ha. The potential for mangrove density can be seen in **Table 4.**

Based on the **Table 4** showed that the mangrove area of West Segara Anakan was dominated by rare density (60%), while the mangroves in East Segara Anakan had mangrove dense reached 43.9 %. The mangrove ecosystem in Segara Anakan from 1994 - 2000 had decreasing trend which give impact reducing function of mangrove ecosystem (Sari et al., 2016). The factors of mangrove decreasing are natural factors and human activities for example are the conversion of mangrove ecosystem into residential areas, industry, rice fields and ponds (Giri et al., 2015; Suhartono et al., 2015; Sari et al., 2016), sedimentation or accretion (Fu et al., 2018; Hilmi et al., 2021e; Nur and Hilmi 2021), heavy metal pollution (Hilmi et al., 2017c; Xiao et al., 2019; Zhang et al., 2019) land use change, logging (Datta & Deb 2017; Hilmi 2018; Hilmi et al., 2019c) and petroleum pollution (Syakti et al., 2013b; Ameen et al., 2016).

The classification of mangrove density in Segara Anakan mangroves using NDVI value could be shown in **Figure 4 and 5**. Mapping of mangrove density in 2019-2020 in the West Segara Anakan were dominated by rare conditions, while in East Segara Anakan was dominated by moderate dense. The results of mapping showed that the density of mangroves in the West Segara Anakan using the NDVI

Table 4. The grouping of mangrove density in Segara Anakan Cilacap

Class of mangrove density	East Segara Anakan		West Segara Anakan	
	Area (ha)	Percent (%)	Area (ha)	Percent (%)
Rare	110.97	8.1	1891.53	60
Moderate	653.92	48.0	788.14	25
Dense	597.69	43.9	472.88	15

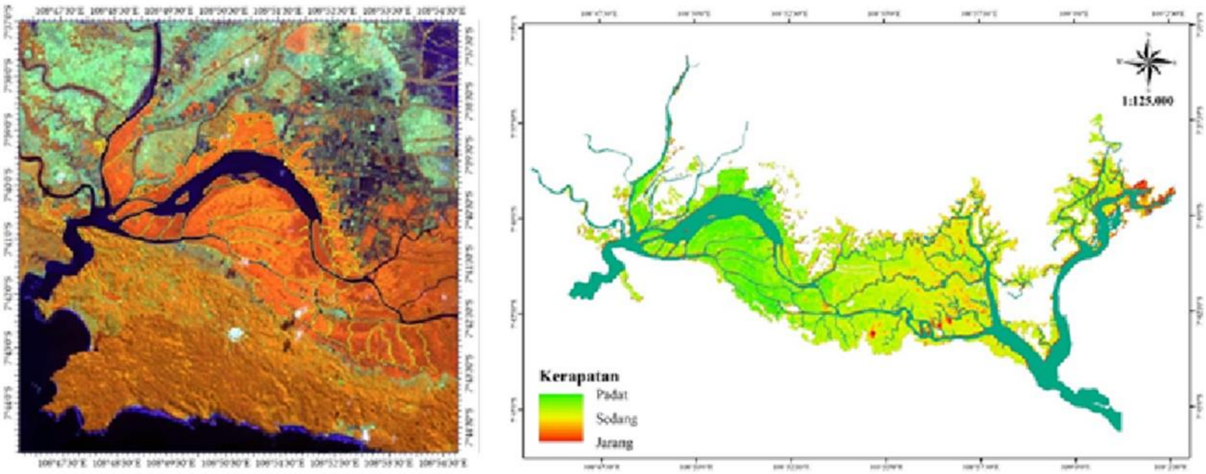

Figure 4. The Normalized Difference Vegetation Index (NDVI) for Mangrove Density mapping in Segara Anakan Cilacap

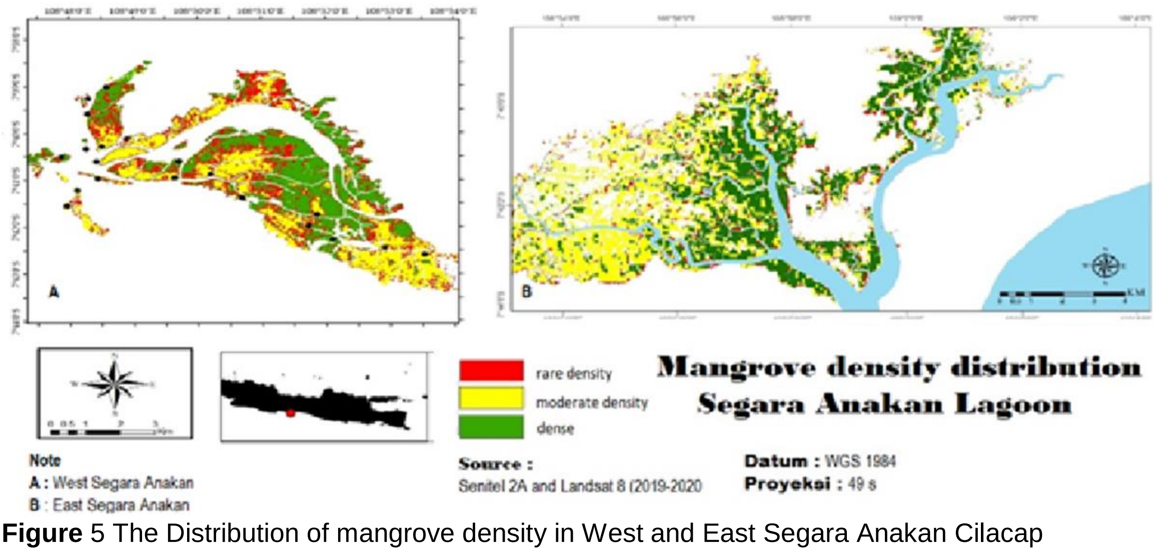

Figure 5 The Distribution of mangrove density in West and East Segara Anakan Cilacap

value, was divided into three classes that were 15% dense conditions, 25% moderate, and 60% rare conditions. Whereas the mangrove in East Segara Anakan had 43.9 % mangrove dense, 48.0 % moderate dense and 8.1 % rare density. The inventory of Mangrove Forest Region Segara Anakan (BPKSA) Kab. Cilacap 2009 (Cahyo 2012) finds that Mangrove forests in the Segara Anakan has degradation trend every year. For example, mangrove ecosystem in the West Segara Anakan, in 1974 the area of mangrove forests was 15,551 hectares, in 1978 had potency reached 10,975 hectares, in 1994 was 8,975 hectares, and in 2003 only remaining 8,359 hectares (Sari *et al.,* 2016)

Basically, mangroves ecosystem in Segara Anakan Cilacap has high ability and adaptation to live and grow in lagoon ecosystem as the intertidal and brackish zone ecosystem. The according of (Dangan-Galon et al., 2016; Njana

2020; Hilmi et al., 2021f) write that mangrove ecosystem is as tropical coastal vegetation communities, which are dominated by many species which must have ability and adaptation to grow and develop in muddy coastal tidal areas. The growth of mangrove community in intertidal areas also are influenced by temperature, salinity, sedimentation, fresh and marine water supply, and protection from large waves and strong tidal currents.

The mangrove ecosystem can grow and live in shallow bays, estuaries, deltas and protected coastal areas (Eslami-Andargoli et al., 2009; Adame et al., 2010; Domínguez-domínguez et al., 2019). But mangroves have handicap to grow in permanent water inundation, sand beach, large waves and strong tidal currents, because potential of sedimentation, deposition, water inundation and sea wave will reduce the ability of mangroves to grow and live (Ferreira et al., 2007; Yang et al., 2008; Kumbier et al., 2021). Mangrove vegetations are often found in regularly inundation area or sea tides area which are protected by high and strong waves (Hilmi 2018; Hilmi et al., 2022a). Bassically, mangrove in Segara Anakan Lagoon have high ability to live and grow in seawater inundation and sedimentation area, because mangrove vegetation in Segara Anakan Lagoon must have ability to reduce impact of high waves, pollution and sedimentation Mangrove must have activity to preserve and protect mangrove live from and the potential of high waves and current. The ability of mangrove vegetations to live and grow are a main and trigger factors to develop survival community and zoning of mangrove ecosystem (Win et al., 2019; Alam et al., 2021; Hilmi et al., 2021c; Yan & Guizhu 2007).

4. Conclusion

The mangrove ecosystem in Segara Anakan Lagoon both of East or West Segara Anakan are dominated by *Sonneratia alba, Rhizophora stylosa, Rhizophora apiculata, Avicennia marina, Aegiceras corniculatum* and *Nypa frutican*. Unfortunately, the potential density area of mangrove ecosystem in Segara Anakan has tends to be dominanted by rare density. This condition must be improved through mangrove rehabilitation activities or mangrove conservation.

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