ISSN 1533-9211

DOI 10.5281/zenodo.7409122

THE ANALYSIS OF SDGS IN THE MANGROVE AREA OF DKI JAKARTA USING THE HYBRID METHOD (USING REMOTE SENSING AND PROSPECTIVE ANALYSIS)

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Abstract

Mangrove ecosystems have many benefits of ecosystem services and can be one of the supporting factors for the SDGs. Indonesia, which is an archipelagic country and is located in the tropics, has a fairly extensive mangrove forest. DKI Jakarta is one of the provinces in Indonesia that has mangrove areas in its coastal areas. Changes in area or increases in the area can always occur over time, so it is necessary to monitor mangrove areas and identify variables that influence this. Based on this, the purpose of this study is to determine the actual and potential condition of the mangrove area and the variables that influence the North Coast of Jakarta. This research was conducted in the northern coastal area of DKI Jakarta Province. The method used in this research is a survey method and prospective analysis by utilizing institutional data and secondary data through remote sensing and GIS and Micmac processing. The results of Sentinel 2A image analysis using the NDVI method for the mangrove area on the north coast of Jakarta is 1192.201 Ha and several key variables.

Keywords: Mangrove actual and potential, remote sensing, prospective analysis, SDGs

INTRODUCTION

Mangrove forests are forests that grow in coastal areas or around river mouths that are influenced by tides, this forest is characterized by tree species Avicennia, Sonneratia, Rhizophora, Bruguiera, Ceriops, Lumnitzero, Nypn, and others (Hilmi et al., 2021a; 2019a; 2021c; 2021d) . In addition to plants or trees, in this forest, there are many other biotas that are interrelated to form an ecosystem (Hilmi et al., 2015). Mangrove ecosystems have several benefits and ecosystem services, for human life such as coastal protection from ocean waves, seawater intrusion, and recreational locations (Hilmi, 2018, Hilmi et al., 2022a; 2017a) in addition to the life of the biota in it (Hilmi et al., 2021b), as a place to find food, shelter, and breed (Brander et al. al., 2012; Malik et al., 2015).

Indonesia, which is an archipelagic country located in the tropics, has a fairly extensive mangrove forest. Hamilton & Casey 2016 stated that the area of mangrove forests in Indonesia

ISSN 1533-9211

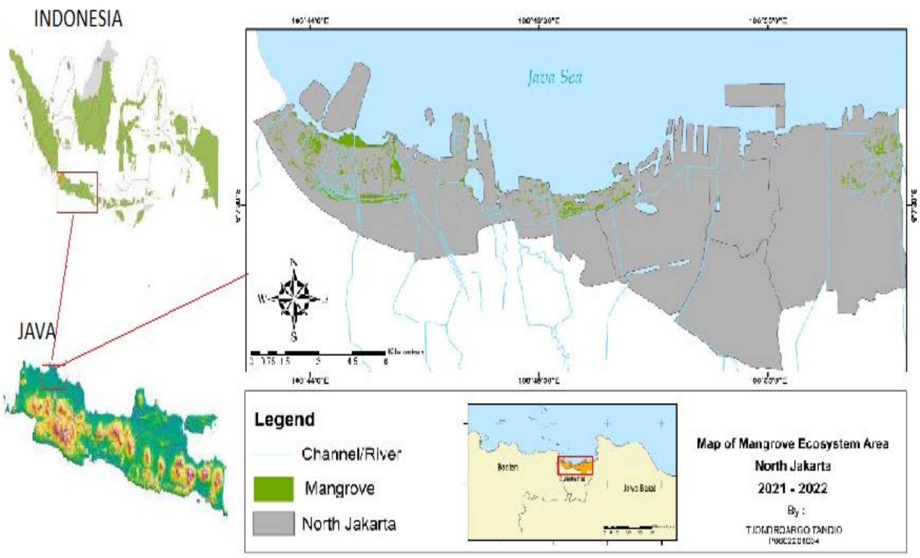
DOI 10.5281/zenodo.7409122

is around 26%-29% of the world's mangroves. The tropical climate with temperatures ranging from 28-300 C is an ideal condition for mangrove life (Syahid et al., 2020), although according to (Kathiresan & Bingham, 2001) mangroves have a temperature tolerance of 8-420 C. Currently, the mangrove ecosystem exists, live and growth. Continue to face challenges and pressures due to activities in coastal areas (Hilmi et al., 2022b; 2021e; Hilmi et al., 2020) . In Indonesia, the trend of decreasing mangrove area during the period 2000-2012 has an average rate of 0.26%-0.66% per year (Hamilton & Casey, 2016). The potential threat of mangrove degradation is even greater in areas close to the center of economic activity (Hernandi, et al., 2013). Coastal areas are also known to be centers of economic activity and development as well. DKI Jakarta is one of the provinces in Indonesia that has mangrove areas in its coastal areas. However, currently experiencing degradation due to human activities, according to research results from 2010 to 2015 there was a change in an area, namely a decrease in the area of 38.79 hectares (Mulyaningsih et al., 2018). This degradation will have an impact on the environment and socio-economics of coastal communities (Malik et al., 2017). Therefore, based on this information, the actual condition of the mangrove ecosystem is important to know because it is related to the sustainability and availability of ecosystem services (Hilmi et al., 2017b). The Angke Kapuk Mangrove Ecosystem (MAK) one of the remaining ecosystems on the north coast of Jakarta and has several ecosystem services, is currently facing a potential threat of degradation so it is very important to know the actual condition of the area. Based on this, this study aims to determine the actual and potential condition of the mangrove area on the North Coast of Jakarta.

MATERIALS AND METHODS

Study area

Figure 1: Study area in Mangrove North of Jakarta



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ISSN 1533-9211
DOI 10.5281/zenodo.7409122

The research consisted of two stages, namely research using remote sensing and field studies. The research location is the North coast of Jakarta, DKI Jakarta Province. Remote sampling was used to see the distribution of mangroves along the northern coast of Jakarta, while field studies to see the condition of water quality and changes in mangrove species were carried out around the Angke Kapuk protected forest in DKI Jakarta. Field studies were carried out in 2021 and 2022 with a smaller study location in the Angke Kapuk protected forest area, North Coast area of Jakarta. The study area covered area between 24º16'58.96"S-24º17'04.49"S and 50º35'00.04"W- 50º34'58.71"W. The study area could be shown on Figure 1

The research Variables

The research variable can be shown on Table 1. The variable divided into two research activities that were (1) the analysis of mangrove mapping and (2) the analysis of main variable of sustainability management of mangrove ecosystem

Table1: The variables research

No	Name of Variables	SDGs Relevant
Main variables of mangrove ecosystem management		
1	Ecotourism and fishing	No Poverty
2	Fisherman activity	No Poverty
3	Provide open space	Good health and well being
4	Clean water	Good health and well being
5	Residential area stability	Good health and well being
6	The community works in the mangrove area	Decent Work and Economic Growth
7	The community works on mangrove ecotourism	Decent Work and Economic Growth
8	The rate of carbon absorption by mangroves	Climate Actions
9	Actual mangrove area	Climate Actions
10	Potential mangrove area	Climate Actions
11	Mangrove density	Climate Actions
12	Environmental law	Partnership for the goals
13	Local regulations Mangrove management in Jakarta	Partnership for the goals
14	Mangrove management institutions	Partnership for the goals
Mapping Variables		
1	Mangrove density	Mangrove sustainability
2	Mangrove area	Mangrove sustainability
3	Water quality and soil	Mangrove environment

Procedures and data analysis

Mangrove density and mangrove area

The analysis mangrove density was conducted using the transect method in Mangrove ecotourism area, Angke Kapuk preservation forest 1, Angke Kapuk preservation forest 2, Angke Kapuk preservation forest 1, Mangrove Arboretum, Mangrove greenbelt (galatama 1), Mangrove greenbelt (galatama 2), Mangrove preservation (Taman Elang) and Suaka

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DOI 10.5281/zenodo.7409122

Margasatwa (SM) of Muara Angke. To analiysis Mangrove density classification in refers to Hilmi et al (2020) can be shown on Table 2

Table 2: Mangrove density criteria

Category	Mangrove density (ind/ha)
Very rare	0 – 390
Rare	391 – 1.610
Moderate	1611 – 2.220
Good density	2.221 – 3.137
Very good density	> 3.137

Sources: Hilmi et al (2020)

The scoping area could be conducted in Jakarta Bay which has an area of 490 km2, with a beach length of about 40 km and an average depth of 15 m, located in the northern part of Jakarta City (Koropitan et al., 2009). The results of Sentinel 2A image analysis using the NDVI method, the mangrove area on the north coast of Jakarta is 1192.201 Ha.

Water and Sediment Quality Analysis

Water quality measurements are carried out directly in the field and analyzed in the laboratory. Parameters directly measured in the field are pH and Salinity, while for water quality parameters NO3-N, PO4-P, and sediment were analyzed in the laboratory using a spectrophotometric method according to the APHA standard method, 23rd Edition, 2017.

The mapping procedure

The mapping procedure used the in situ data and secondary data through remote sensing and GIS processing. The field survey is carried out as one of the input data in interpreting satellite imagery. Field survey activities include: tracking using GPS, collecting field data such as mangrove species, stem diameter and number of stands. In addition, other environmental parameters such as water and sediment quality conditions were also taken to see the characteristics of the sand, silt and clay content, this water quality parameter was taken only once.

a. Acquisition of Satellite Imagery Data and Pre-processing Stage

Sentinel MSI Level 2A satellite image data was obtained through the Google Earth Engine platform using an image retrieval process based on dataset searches in Earth Engine Explorer. Then, the image data that has been called is filtered by the cloud and the date of image recording is in 2021 which is done in the workspace code editor. After doing the filtering stage, then the location selection process is carried out, namely on the North Coast, Jakarta using geometry tools. Then, proceed with the process of mosaicing, which aims to unite several scenes from the image to become one according to the specified area.

b. Supervised Classification

The distribution of the mangrove delineation area was obtained from the results of cropping data based on the supervised classification process of Sentinel-2A images. In the supervised

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classification process, data from field sampling is needed which will be validated with the training area that has been created previously. The classification method used is the Maximum Likelihood Classification method which determines the value of pixels in one class based on the distance weighted in the covariance matrix and the probability of a pixel being included in that class (Dwiputra et al., 2020).

c. Interpretation and Calculation of Mangrove Density Actual Area

The image data has been pre-processed and the mangrove area has been delineated, then the area is calculated for each density class using the NDVI (Normalized Difference Vegetation Index) transformation method. The NDVI is an index of vegetation 'greenness' or the photosynthetic activity of vegetation and is one of the most frequently used vegetation indices. Generally, researchers classify mangrove density levels based on the NDVI transformation method (Hanan et al., 2019; Maulidiyah et al., 2019; Kawamuna et al., 2017; Rumada et al., 2015; Purwanto et al., 2014; Arhatin and Wahyuningrum, 2013). NDVI 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) is:

$$\text{NDVI} = \frac{(NIR - Red)}{(NIR + Red)} \qquad (1)$$

Keterangan:

NIR : Digital Number (DN) data citra pada kanal Near Infra-Red

Red : Digital Number (DN) data citra pada kanal Red (Merah)

d. Interpretation and Calculation of Mangrove Potential Land Area

The process of forming a spatial model of potential mangrove land is carried out using the Spatial Analyst method with the Raster Calculator tools found in ArcGIS software. The manufacturing process uses North Jakarta DEM and the highest sea level value (HHWL) is corrected by the MSL value. Land height values that are below the value of the HHWL deviation to MSL are areas affected by the tides, while the elevation values that are above the HHWL deviation value to MSL are areas that are not affected by the tides. The area of land that is still affected by the tides is overlaid with inundation/wetland which is known from the NDWI transformation calculation. The formula for the Normalized Difference Water Index (NDWI) is:

$$\text{NDWI} = \frac{(Green - NIR)}{(Green + NIR)} \qquad (2)$$

Keterangan:

Green : Digital Number (DN) data citra pada kanal Green (Hijau)

NIR : Digital Number (DN) data citra pada kanal Near Infra-Red

Model lahan-lahan potential mangrove yang dihasilkan kemudian dihitung luasan yang terbentuk di tiap daerah di Jakarta Utara.

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The Focus Group Discussion

The variables of SDGs for mangrove area in North Coast Jakarta was analysed by dealing with 14 variables. This study uses the prospective structural paradigm method to explore the structure, dynamics and interrelationship network between variables which are considered the most important in the development of mangrove areas in DKI Jakarta. Data was collected using the Focus Group Discussion (FGD) method to determine the influential and decisive variables in the development of the area and workshops in the process of filling out the software used in data analysis. Implementation of the discussion using the world cafe method to encourage interaction, knowledge sharing and transfer of experience among participants. The FGD participants totaled 17 people representing stakeholders in the DKI Jakarta area from the DKI Jakarta DPRD, area developers, the ecotourism sector, fishermen, entrepreneurs, warehousing, industry, the community and elements of the mangrove lover community.

Micmac Analysis

Data analysis using the Micmac Method (Cross Impact Matrix Multiplication Applied) to Classification). Micmac is software developed by the Institut d'Innovation Informatique pour I'Entreprise (Godet, 2000), to update the structural analysis method from the previous qualitative to quantitative (Maria del Mar Delgado-Serrano, Ambrosio-Albalá, & Francisco, 2015). In its operation Micmac applies matrix properties (Arcade, Godet, Meunier, & Roubelat, 1999; Durance et al., 2006). The purpose of Micmac is to identify and analyze the main variables of a system. The advantage of Micmac compared to other structural methods is that it allows for grouping and determining the hierarchy of strategic variables of a system and knowing their mutual effects. This feature is very useful in the policy-making process because it will direct the focus of the policy, considering that policy focus often leads to irrelevant variables, failing.

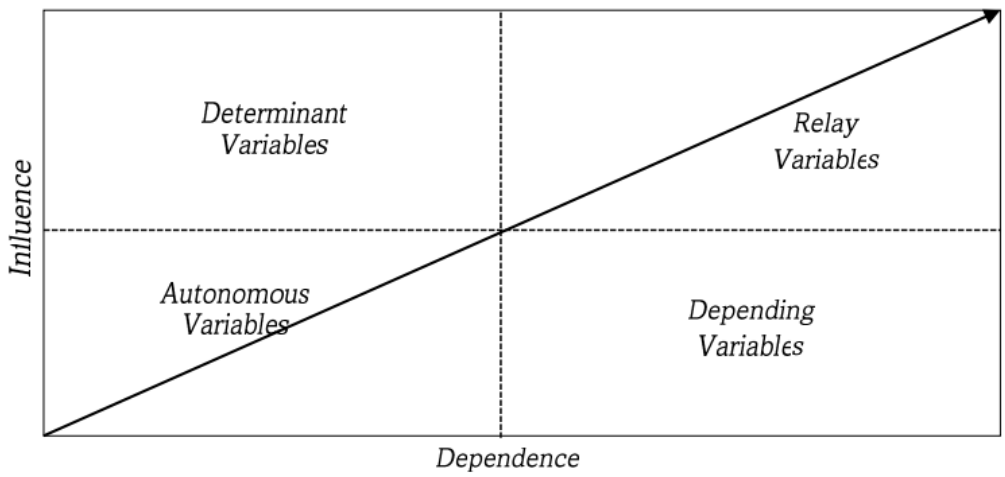
The explanations provided by the Micmac analysis will create greater confidence and trust in the issues raised and present various assumptions (Benjumea-Arias, Castañeda, & Valencia Arias, 2016). The operation of the Micmac method consists of several stages, namely: (1) problem definition, identification of internal and external variables; (2) assessment of the relationship between variables according to the level of influence and dependence, which was assessed with a rating scale between 0 = none, 1 = weak, 2 = moderate, 3 = strong, P = potential. The results of the assessment will qualify the intensity of influence between variables into groups of direct influence, indirect effect, and potential influence. A direct effect occurs if variable A has an effect on variable B; Indirect effect occurs if variable A affects B and B affects variable C, and thus C is indirectly affected by A. Potential effect occurs if variable A should affect B, whereas no direct effect occurs if a variable has no effect on variable others (María del Mar Delgado-Serrano et al., 2016); (3) analyzing the intensity of the influence and dependence of the variables determined by the location of the variables on the quadrant map of the influence and dependence of the variables (Figure 2).

Figure 2 helps analyze the influence and dependence of system variables and groups them into four typologies which include determinant variables, relay variables, autonomous variables,

ISSN 1533-9211
DOI 10.5281/zenodo.7409122

and output variables. The determinant variable is a variable that is very influential and slightly dependent on other variables. These variables are considered as inputs and largely determine the mobility of the system. The determinant variable is a very important variable and requires maximum attention from policymakers because it greatly influences other variables. Relay variables (stake variables) are also called key variables. The relay variable is very influential and at the same time very dependent on other variables. These variables are the least stable because any influence that occurs on them can flow throughout the system. The relay variable is also called the instability factor because it has a "boomerang effect" on the system, meaning that actions on this variable will affect the direction of system mobility. Autonomous variables (autonomous) are variables that have a small effect and are slightly dependent on other variables. This variable has a low potential to produce changes (trend inertia) in the system. Autonomous variables are also known as excluded variables. Autonomous variables are divided into disconnected variables and secondary levers (Albala, Lozano, & Hernández, 2009). Discontinuous variables and their evolution are close to the origin, therefore they can be excluded from the dynamics of the system. While the secondary lever variables are located above the diagonal line, with certain actions these variables can strengthen the system. Output variable or also called the dependent variable. The output variable describes the impact resulting from other variables, especially the determinant variable and the relay variable. This variable is located in the southeastern quadrant of the map. The location of the output variable shows a variable that has little influence with a high dependence so the variable is very sensitive to the influencing factors. This variable becomes a descriptive indicator of the evolution of the system. These variables are then compiled in the Micmac software on the Matrix of Direct Influence (MDI) to determine the intensity of the influence of each variable. MDI is the basic matrix for compiling the Matrix of Indirect Influence (MII) which shows the intensity of the indirect influence of variables, and the Matrix of Potential of Direct Influence (MPDI) which projects the intensity of the influence of variables if the system changes (at a later time)

Figure 2: The Micmac analysis



ISSN 1533-9211

DOI 10.5281/zenodo.7409122

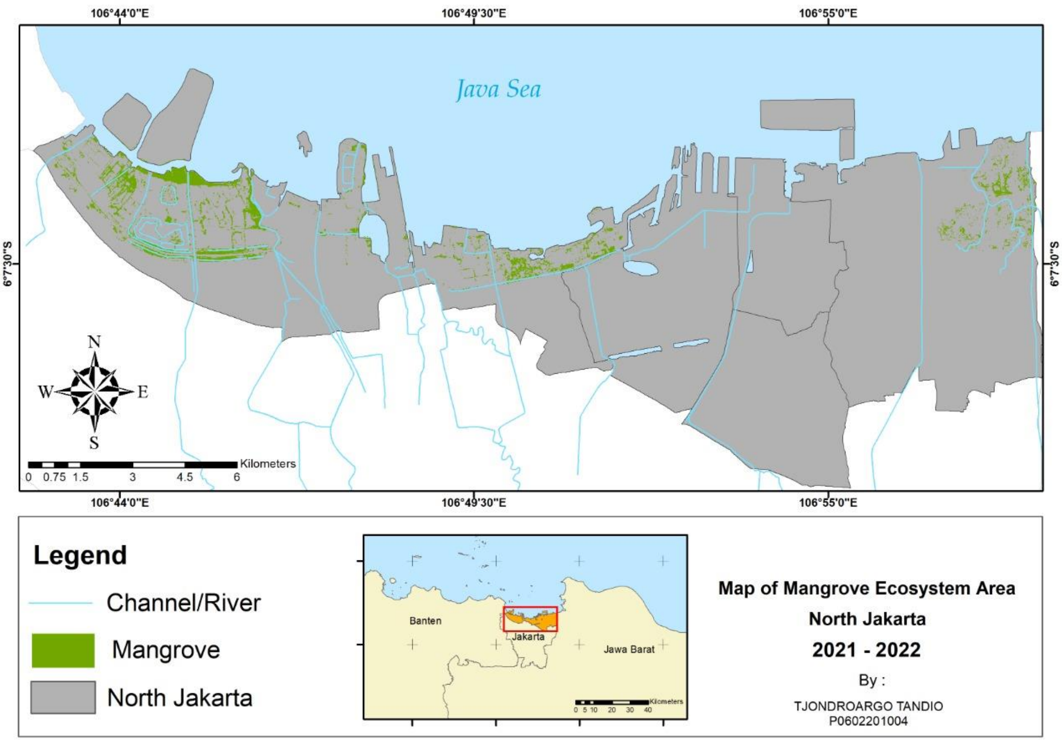
RESULTS

The Actual and Potential Area of Mangrove Ecosystem in North Coast of Jakarta

The actual area of Mangrove Ecosystem in North Coast of Jakarta

Jakarta Bay has an area of 490 km2, with a beach length of about 40 km and an average depth of 15 m, located in the northern part of Jakarta City (Koropitan et al., 2009). The results of Sentinel 2A image analysis using the NDVI method, the mangrove area on the north coast of Jakaraa is 1192.201 Ha (actual area) and 491,75 ha (Potential area) . In detail the distribution of mangrove vegetation is presented in Figure 3 and Table 3. This data on Mapping represents the causal effect mainly explains the actual and potential of mangrove area in North Coast of Jakarta.

Figure 3: North Jakarta Mangrove Ecosystem Area Map analysis results using NDVI on sentinel image 2A



If divided by sub-district administrative boundaries, the distribution of mangroves in DKI Jakarta is divided into four sub-districts, namely Penjaringan, Pademangan, Tanjung Priok, and Cilincing sub-districts. Sequentially, from the largest to the smallest, the distribution of mangroves is in Penjaringan sub-district which is 727.26 ha, Pademangan sub-district 225.12 ha, Cilincing sub-district 226.58 ha, and the smallest is mangrove in Tanjung Priok sub-district 10.88 ha. In figure

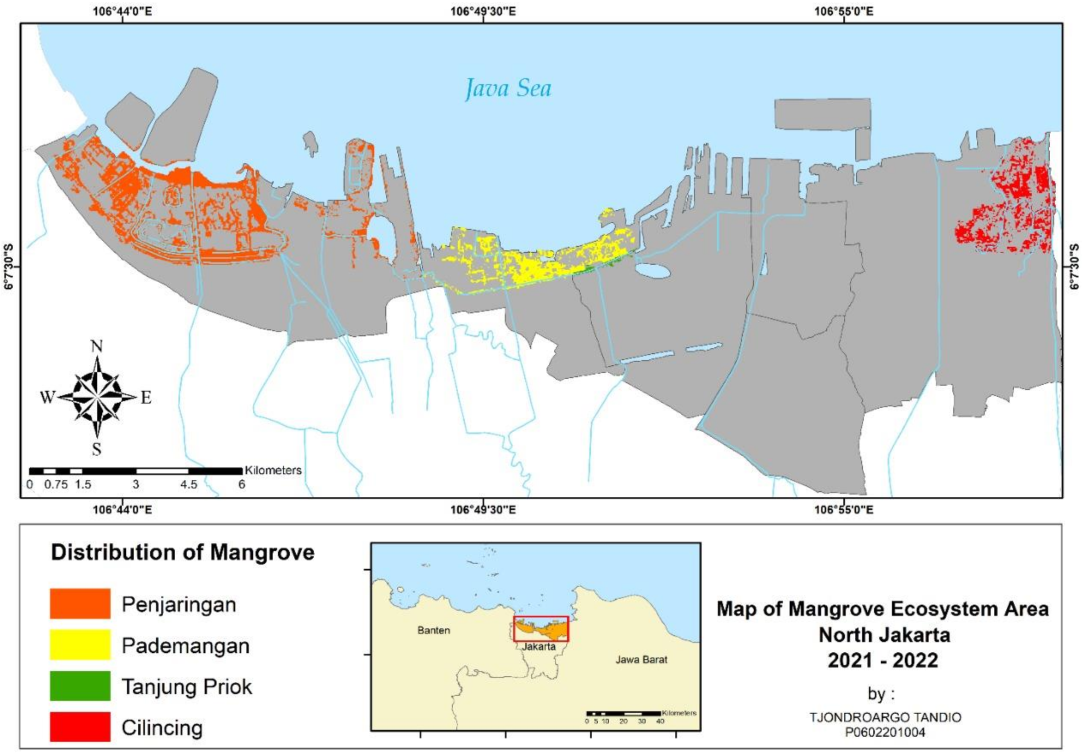
ISSN 1533-9211
DOI 10.5281/zenodo.7409122

Table 3: Potensi Actual dan Potential of Mangrove Area in North Coast of Jakarta

Regency in North Coast Jakarta	Mangrove Area of Mangrove Ecosystem in North Coast of Jakarta (Ha)		
	Actual area	Potential Area	
Penjaringan	727,26		
Pandemangan	225,12		
Tanjung Priok	10,88		
Cilincing	226,58		
Total	1189,84	491,75	1681,59

The distribution of mangrove ecosystem in North Coast of Jakarta also can be shown on Figure 4. The mangrove area in Penjaringan > Pademangan and Cilincing > Tanjung Priok. The mangrove ecosystem area in Tanjung Priok was used as the other of land use such as industry, settlement and market

Figure 4: Distribution of mangroves in North Jakarta by sub-district



The potential area of Mangrove Ecosystem in North Coast of Jakarta

The potential area of mangroves is based on the analysis of sentinel 2A images using the NDWI formula to see wetlands/inundation. Based on the analysis of the potential distribution of the mangrove area, it can be seen in Figure 5. The total potential area of mangrove is 491.75 ha spread along the north coast of DKI Jakarta Province.

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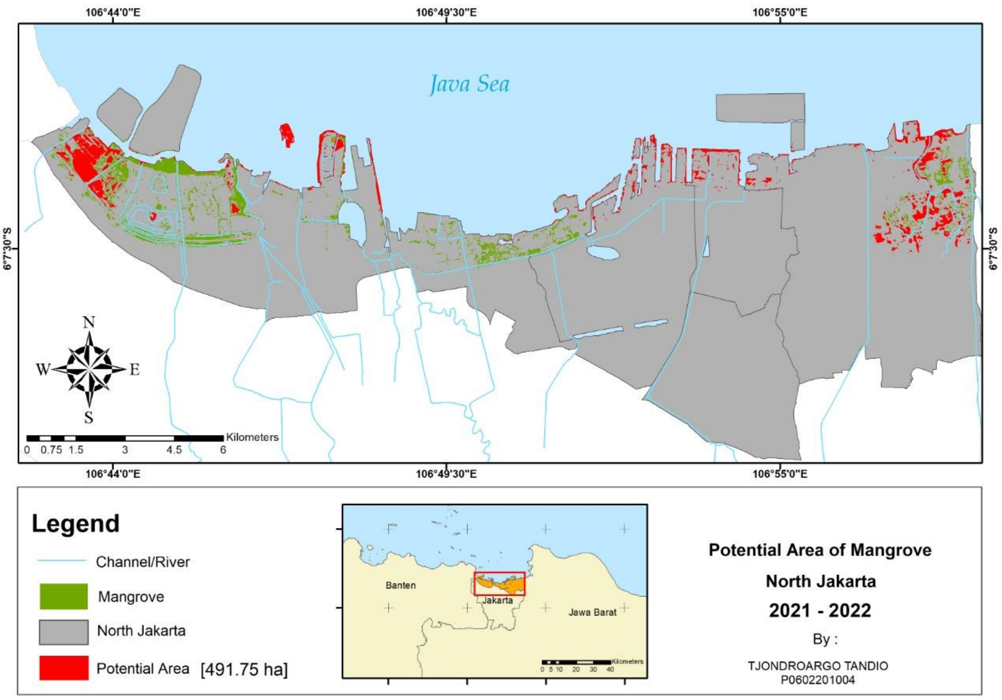
DOI 10.5281/zenodo.7409122

Figure 5: Potential Mangrove Area in North Jakarta using NDWI with sentinel image 2A



The mangrove Area and Density in North Coast of Jakarta

Based on the results of a field survey in 2021 and 2022, the number of mangrove species found in the four observation stations is 12 species that were Avicennia marina Bruguiera gymnorhiza, Calophyllum inophyllum, Cerbera manghas, Excoecaria agallocha, Nypa fruticans, Rhizophora apiculata, Rhizophora mucronata, Rhizophora stylosa, Sonneratia caseolaris, Soneartia Alba, Terminalia catappa and Thespesia populnea (Table 4 and Figure 6). When compared with the 2022 data, the number of mangrove species found also amounted to 12 species but there were differences in species found, in 2020 there was a Soneartia alba species that could be found at station 3 with a density of 160 individuals/ha. Meanwhile, in 2021 the species of Soneartia alba will no longer be found at station 3 or other stations, but mangroves of the Calophyllum inophyllum species are found at station 1 with a density of 20 ind/ha.

Avicennia marina species experienced an increase in density from 310 ind/ha to 1600 ind/ha, besides that, Rhizophora stylosa also experienced a significant increase in density from 179 ind/ha to 1380 ind/ha. Meanwhile, Nypa fruticans and Rhizophora mucronate species decreased in density in 2021 from 1190 Ind/ha to 260 ind/ha and 2470 ind/ha to 120 ind/ha, respectively. When viewed as a whole, the density of each station at station one has increased from infrequent to moderate, while at the other stations there is no change.

ISSN 1533-9211

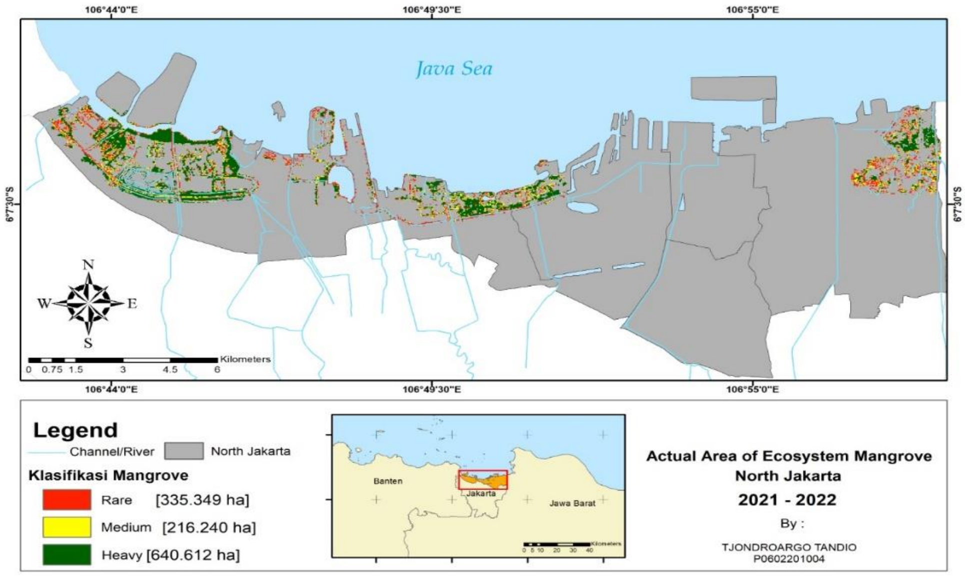
DOI 10.5281/zenodo.7409122

Table 4: Number of Mangrove Types in 2021 and 2022

Jenis Mangrove	2021				2022*			
	Kerapatan (Individual/ha)				Kerapatan (Individual/ha)			
	Stasiun				Stasiun			
	1	2	3	4	1	2	3	4
Avicennia marina	200	-	-	110	240	520	220	620
Bruguiera gymnorhiza	30	-	20	30	40	20	-	-
Calophyllum inophyllum	-	-	-	-	20	-	-	-
Cerbera manghas	20	-	-	-	-	80	-	-
Excoecaria agallocha	10	-	-	-	80	100	-	260
Nypa fruticans	-	-	1,190	-	80	-	180	-
Rhizophora apiculata	-	6	-	-	-	-	80	-
Rhizophora mucronata	410	900	50	1,110	20	80	20	-
Rhizophora stylosa	150	29	-	-	1,180	80	80	40
Sonneratia caseolaris	200	224	-	80	20	20	20	20
Soneartia alba	-	-	160	-	-	-	-	-
Terminalia catappa	40	-	-	-	120	120	-	-
Thespesia populnea	-	-	-	-	-	-	-	40
Average	82	89	109	102	38	78	46	75
Total	1,060	1,159	1,420	1,330	1,800	1,020	600	980
Classification	rare	rare	rare	rare	middle	rare	rare	rare

The results of interpretation using sentinel 2A imagery, the distribution of mangrove density in the north of DKI Jakarta province can be seen in Figure x. The density classification is divided into three groups, for the rare density, the area is 335,349 ha, the medium density is 216,240 ha and the dense density is 640,612 ha. When divided into three regions, namely the western, central and eastern areas, the largest dense density is in the western area, the western area is the area that has the largest mangrove area, while the eastern area is the area that has the smallest mangrove area and the highest dense density class low.

Figure 6: Distribution of mangrove density in North Jakarta by sub-district



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DOI 10.5281/zenodo.7409122

The environment factor (Soil and water quality) of mangrove ecosystem in North Coast of Jakarta The water quality parameters observed during the study were pH, NO3-N, PO4-P, and salinity (table 3). The results of water quality observations at the four stations showed that the pH value ranged from 6.23-6.37, the value of the NO3-N content ranged from 0.1415-0.2275 mg/l with the highest value being at station 1, the PO4-P content ranged from 0.1715-0.226 mg/l with the highest value at station 1 and the salinity values of the four stations ranged from 5.56-6.28 ‰

Table 5: Water quality and sediment content of North Jakarta mangrove area

Stasiun	pH	NO_3-N	PO_4-P	Salinitas	Pyrite	Sand	Silt	Clay
		mg/l	mg/l	(‰)	(ppm)	(2-0.05 mm)	(0.05-0.002 mm)	(‹0.002 mm)
St 1	6.375	0.2275	0.226	5.85	0.2475	11.61	66.825	21.565
St 2	6.25	0.1735	0.1975	5.56	0.264	12.64	77.13	18.23
St 3	6.345	0.159	0.1745	6.005	0.184	11.635	67.785	20.58
St 4	6.235	0.1415	0.1715	6.275	0.171	13.725	66.47	19.805

The pyrite content in the sediment from the four stations ranged from 0.171-0.248 ppm with the highest value being at station 1, station one the composition of sediment consisted of 11.61% sand, 66.82% silt and 21.56 clay; station two the sediment composition consists of 12.64% sand, 77.13% silt and 18.23% clay; station three sediment composition consisting of 11.63% sand, 67.78% silt and 20.58% clay; for station four, the highest proportion of sediment content is silt 66.47%, sand 13.72% and clay 19.80%.

The main variable of mangrove management in North of Jakarta

The results of this study are largely determined by the accuracy of the sources in identifying the variables that are thought to affect the development of mangrove areas in DKI Jakarta. To achieve this, in the early stages of FGD participants were given an orientation by experts about the benefits of mangroves for SDGS in DKI Jakarta. After that, a list of variables was made based on the understanding, knowledge, and experience of the participants. The results of the discussion identified fourteen variables that were considered to affect regional development. These key variables are grouped into five clusters of factors forming the development of natural tourist destinations as shown in Figure 7 and Figure 8. These variables are then compiled in the Micmac software on the Matrix of Direct Influence (MDI) to determine the intensity of the influence of each variable. MDI is the basic matrix for compiling the Matrix of Indirect Influence (MII) which shows the intensity of the indirect influence of variables, and the Matrix of Potential of Direct Influence (MPDI) which projects the intensity of the influence of variables if the system changes (at a later time).

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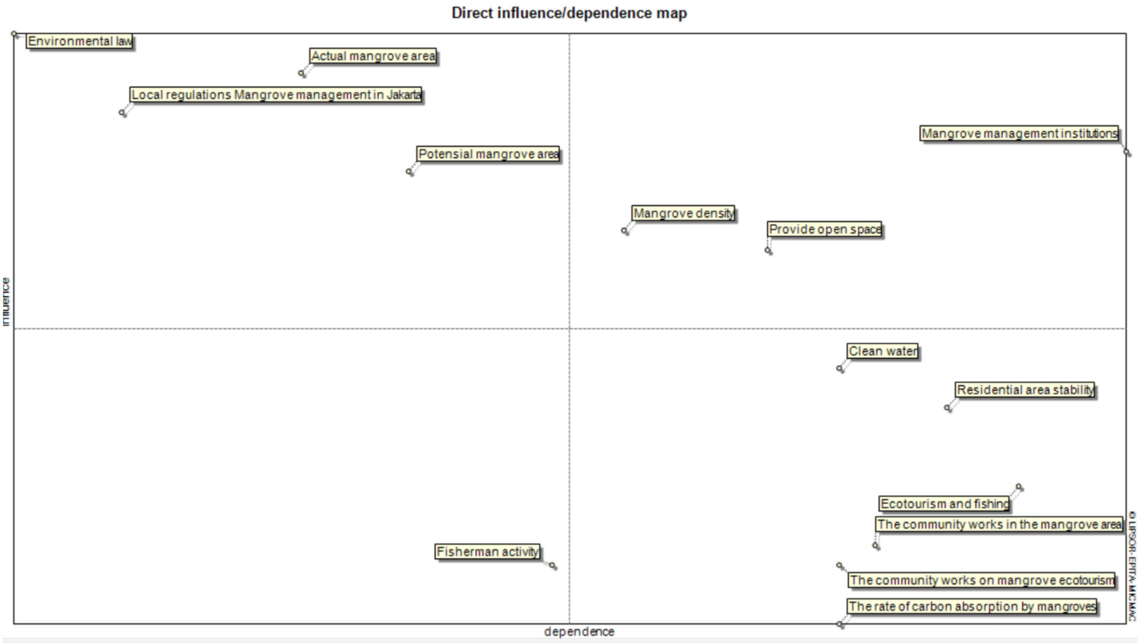
Figure 7: The matrix of direct influence

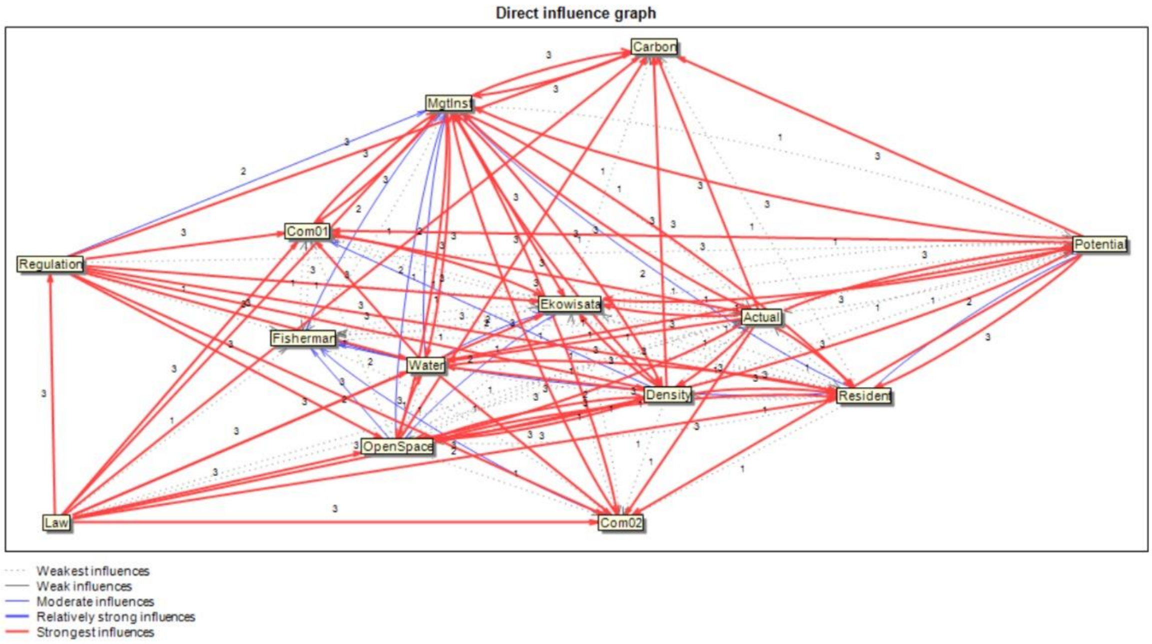


Matrix of Direct Influence (MDI) MDI is the original matrix and is the input data for the Micmac method. The MDI is filled with values ranging from 0-3 and P to determine the intensity of the direct influence and the direct influence of each variable on other variables. The results of filling in the MDI determine the position of the variables on the direct influence and dependency map into four typologies as shown in Figure 7, namely: the determinant variable, which is generated from the Micmac analysis, resulting in four variables that are included in the determinant quadrant, namely: environmental law, Perda Mangrove Management in Jakarta, the actual mangrove area and the potential mangrove area. The four variables represent the main problem that is very crucial in this area, because the authority to determine regulations and special permits are not at the meso level but at a higher level of government, namely: the Ministry of Environment and Forestry and the DKI Jakarta Province. If these findings are followed up by the most competent parties, it will be a very appropriate breakthrough in dealing with the sectoral ego problem between the main middle-level institutions in the northern coastal area of DKI Jakarta. The existence of special regulations and local regulations will determine the dynamics of variables in the other quadrants. The relay variable is the most important and requires maximum attention from policymakers. From the system perspective, the variables located in this quadrant are the process elements that will greatly determine the output. There are three variables included in this quadrant, namely: mangrove management institutions, mangrove density, and availability of open space. These variables should be the focus of the attention of policymakers. The dependent variables include the availability of clean water, the stability of residential areas, ecotourism and fishing, people who work in mangrove areas, people who work in the ecotourism sector, and the level of carbon sequestration by mangroves. This variable is the output of the development of mangrove areas

ISSN 1533-9211
DOI 10.5281/zenodo.7409122

in DKI Jakarta. The results of this analysis can be a "coercion" for policymakers to pay greater attention and carry out an in-depth analysis of these variables because it is a hope in the future to overcome problems, especially those related to limited employment opportunities, poverty, and welfare as well as sea and water intrusion. Subsidence, the autonomous variable, is fishermen. Variables include secondary levers because they are far from the origin and above the diagonal line. This position can be interpreted that this variable does not influence the dynamics of the system. Thus, its nature is relatively difficult to change and can be ignored.

Figure 8: The matric direct influence relationship



DISCUSSION

Our study found that there was a change in the number of individual species from 2021 to 2022. In 2021 the most common species found were Rhizophora mucronata, which was 2470 individuals/ha, while in 2022 it decreased to 1380 Ind/Ha, in 2022 the number of species increased. Is Avicennia marina, which is 1600 ind/ha from 310 ind/ha in 2021 (table 2). This is following research (Rumondang et al., 2021; Hilmi et al., 2021a; 2021c; 2021d) which explains that the species that dominates the Angke Kapuk mangrove area is A. Marina, R. styllosa, R. mucronate and R. apiculata. According to (Martuti et al., 2017; Hilmi et al., 2021d; 2022a; 2022d) the genus Avicenia and Rhizophora are a mangrove genus that is resistant to environmental pressures and its position is located on the border of the coastal zone. The study (Sari et al., 2019; Hilmi et al., 20221, 2021a, 2021b, 2021c; 2021d) showed that the genus Avicenia and Rhizophora are at the border of the coastal zone, but their response to water quality can decrease which means the genus has a tolerance limit with a bad environment. The

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ISSN 1533-9211
DOI 10.5281/zenodo.7409122

Angke Kapuk mangrove area is an area located in a built-up area (Sofian et al., 2019), so the environmental pressure is very high and can affect the life and growth of mangroves.

The salinity conditions measured during the study ranged from 5-6 ppt, in general mangroves can tolerate high salinity but depend on the type of plant (Toriman et al., 2013; Hilmi et al., 2021a, 2017b, and 2020). Another study (Bayan et al., 2016) revealed that the condition of the mangrove area in Angke Kapuk which is at the mouth of the river and the coast affects changes in water salinity, besides that there is a lot of mud, this makes the genus Avicenia and Rhizophora still able to grow. The levels of NO3-N ranged from 0.1415-0.2275 mg/l and PO4-P ranged from 0.1715-0.226 mg/l. This value was not much different from that carried out by (Bayan et al., 2016) at Angke Kapuk Beach (Hilmi et al., 2022a; 2021d; 2022b). In general, mangroves are not affected by nitrogen or phosphorus content in the waters (Kathiresan & Bingham, 2001), but the sediments in the mangrove area are efficient for binding phosphorus contained in the waters and less effective for nitrogen (Tam & Wong, 1995). Meanwhile, the nitrate content will be utilized by phytoplankton and aquatic plants, including mangroves, for processes such as photosynthesis, respiration, and protein synthesis and as a constituent of genes and the growth of organisms (Alongi et al., 2011).Hasil analysis baser butir menunjukan bahwa sedimen di Kawasan mangrove Jakarta didominasi oleh silt, clay dan sand, hal terse but sesuai dengan penelitian (Bayan et al., 2016; Sari et al., 2019). Secara hidrology terdapat 13 sungai yang melewati wilayah Jakarta dimana 3 sungai besar bermuara di teluk Jakarta yaitu sungai Citarum, sungai Ciliwung dan sungai Cisadane

Based on the results of the potential analysis of the mangrove area identified using the NDWI method, it is an area of 491.75 ha. The NDWI (Normalized Difference Water Index) method is used to separate water and non-water (Suwarsono et al., 2020; Hilmi et al., 2022a; 2021a), in this study this method is used to see which areas can still be planted with mangroves. As explained by previous researchers (Twilley & Rivera-Monroy, 2005) factors that affect mangrove restoration or planting include nutrients, light, and water, the water is divided into the duration of inundation and salinity levels. The availability of seeds is also a factor in mangrove planting (Rahadian et al., 2019; Hilmi et al., 2021a; 2021b; 2019a; 2021c; 2015). In this study, we only identify which areas are inundated by water using the NDWI method as a preliminary study when mangrove planting is carried out. However, it is not enough just to use the NDWI method in the future, further studies need to be carried out, related to land suitability and other factors that affect mangrove growth.

CONCLUSION

The condition of mangroves on the north coast of DKI Jakarta is under pressure, one of which is due to human activities, density conditions and changes in the density of mangrove species are evidence of mangrove areas experiencing pressure, based on satellite imagery analysis, the potential for mangrove areas in Jakarta Bay is still there, which is 491.75 ha and this is possible. Expansion or reforestation of mangroves, but a more detailed study is needed regarding the suitability of mangrove land. This study has succeeded in identifying strategic variables, and the order of priority scales which are the key variables in the sustainable development of

ISSN 1533-9211

DOI 10.5281/zenodo.7409122

mangrove areas in DKI Jakarta. These variables are quite comprehensive covering several aspects of SDGs, namely: No Poverty, Good health and wellbeing, Decent Work and Economic Growth, Climate Actions and Partnership for the goals

The findings of this study become a very strong foundation for all parties involved in policy making to focus their policies on the variables contained in the determinant and relay quadrants that have a strong influence on other variables. By understanding the results of this study, all key stakeholders can be involved in decision making through a good governance system. The results of regional development are expected to have an impact on the expansion of employment opportunities, reduction of poverty, and availability of funds for the community and improvement of community welfare, climate control through absorption carbon, anticipating land subsidence and seawater intrusion into land

ACKNOWLEDGEMENTS

The authors express gratitude to PSL program in Postgraduate School IPB University, and Institute for Research and Community Services (LPPM) Universitas Jenderal Soedirman for providing research grant (Hibah Riset Institusi 2022). The authors also appreciate anonymous reviews for significantly improving this paper.

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