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Structuring the *Bruguiera gymnorrhiza* Mangrove Area for Food Security in Paciran Village, Paciran District and Labuhan Village, Brondong District, Lamongan Regency, East Java

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ABSTRACT

The results of the GSCA show that the *Bruguiera gymnorhiza* mangrove forest is an alternative source of food for local people that can be mixed with rice, and made various kinds of food diversification. The NDVI results show that the mangrove density with the dominance of *Bruguiera gymnorhiza* species needs to be rehabilitated and restored to increase its density and density. Considering that the location of the mangrove forests in the two research villages is in water areas, it is necessary to have a policy to convert rice fields back to the growth of mangrove land. The policy of the Lamongan district government which is contained in the strategic plan policy to optimize coastal land into the development of residential areas, industrial areas need to be updated and revised into protected areas. Mangrove forest areas are managed for the use of mangrove forests as an alternative to food by dividing the area into a no-take zone and a limited economic area that can only be used as a food source area for the community.

Key words: *Bruguiera gymnorrhiza, GSCA, NDVI, Conservation*

Introduction

Research by Setijawati *et al.* (2020) indicated that the mangrove buguiera gymnorrhiza can be used as a food source because it contains carbohydrates that are soluble in water. Among the many mangrove fruits suitable for exploitation as a new local food source is the Bruguiera gymnorrhiza species. This is because this species contains very high carbohydrates. Besides that, the mangrove ecosystem has economic benefits, namely wood and non-timber products. For example, brackish water cultivation, shrimp ponds, tourism. Ecological benefits in the form of protection for terrestrial and marine ecosystems, namely by being a barrier to abrasion and erosion of waves or strong winds. Ecosystem plays a role in stabilizing coastal ecosystems both physically and biologically (Bandaranayke, 2002). Dyah *et al.* (2020) stated thatthe calorific value of the fruit flour of Bruguiera gymnorrhiza is 365.63 kcal/100 g. The nutritional value of *Bruguiera gymnorrhiza* wet noodles showed a very significant difference in water content, protein, fat, ash, carbohydrates and crude fiber. However, the caloric value showed no significant difference. The results of the organoleptic test on the four test parameters showed a decreasing value along with the increase in substitution of *Bruguiera gymnorrhiza* flour. The most preferred treatment is the substitution of 20% *Bruguiera gymnorrhiza* flour. Coastal communities have long used mangrove forests to fulfill their daily lives, especially for food and medicine. The types of mangroves used vary widely, including major mangroves, minor mangroves, and associated mangroves. However, what type of mangrove has the most potential is not mentioned. Unfortunately, the community uses the mangrove forest incorrectly, that is, the trees are cut down to be converted into ponds, residential areas, trade areas, and industrial areas. Even though the benefits of mangrove forests are multi-use (Kusuma, 2018). The impact that occurs due to the conversion of mangrove land causes damage to coastal areas. Stevenson (1997) stated that efforts to rehabilitate mangroves in abandoned ponds in coastal areas of Indonesia began in the 1990s. However, replanting seedlings with a single mangrove species became the most popular option in Indonesia at that time (Field, 1999; Kamali and Hashim, 2011; Kusmana 2017; Djamaluddin *et al.* 2018). This is a reasonable choice because rehabilitation efforts are usually time constrained and require large amounts of funds that only donor countries can provide.According to Brown *et al*. (2014) many efforts to rehabilitate mangroves in Indonesia have failed, and the main factor is the misconception that mangrove rehabilitation can be carried out using only Rhizophora seeds. Furthermore, Muhammad Ilman *et al*. (2016) stated that the degradation of coastal areas in Indonesia began with the development of ponds for brackish water shrimp farming. Besides that, mangrove wood is also used for various kinds of community needs. As a result, it is estimated that the area of mangrove forests in Indonesia that has been lost is more than 200,000 hectares. The shrinkage of the mangrove forest area is increasing when land conversion shifts from Java and Sumatra to outside Java such as Kalimantan and Sulawesi. According to

Bayu *et al*. (2021) refer to FAO (2007) that Indonesia, mangrove area has declined at a rate of 1.24% per year, from 4.2 Mha in 1980 to 2.9 Mha in 2005. The last estimates indicate that Indonesia's remaining mangrove area is approximately 3.1 Mha (Giri *et al.,* 2010).

Until now, the process of land conversion continues. Like in Lamongan Regency, East Java province. The damage to mangrove forests in this area is also intensive, but some areas are also undergoing repairs. The consequences of mangrove degradation affect service functions and reduce benefits for the community, because the ability of mangroves to prevent waves and wind and abrasion is greatly re-

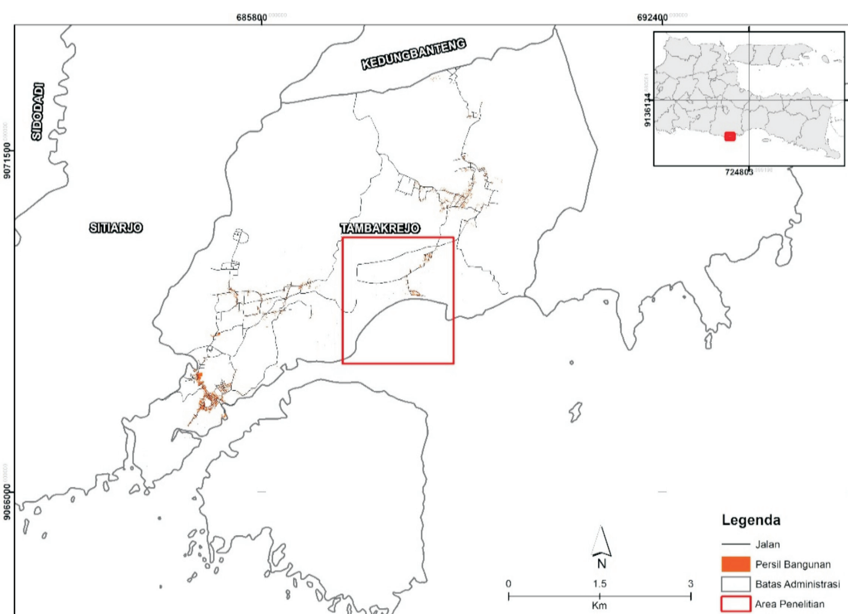

Fig. 1. Map of Lamongan regency in East Java

duced (Laura *et al.*, 2018; Spalding *et al*., 2014).

Materials and Methods

The Study area

Lamongan regency is located 6º51′54′′ to 7º23′6′′ south latitude and between 112º4′41′′ to 112º33′12′′ east longitude. Based on its geographical position, Lamongan has boundaries: In the north it is bordered by the Java Sea; to the south, it is bordered by Jombang and Mojokerto Regencies; in the west it is bordered by the regencies of Bojonegoro and Tuban; the east is bordered by Gresik Regency. Lamongan Regency has an area of approximately 1,812.8 km^2 or +3.78% of the total area of East Java Province. With a coastline of 47 km, the sea area of Lamongan Regency is 902.4 km^2, when calculated 12 miles from sea level (Central Bureau of Statistics, 2020).

Study area

Based on the East Java provincial government (2017) that the priority issues formulated by the East Java provincial government and the Lamongan district government are land use change and forest degradation.

Forest damage in Lamongan Regency in 2016 was 528 Ha. The main causes of forest destruction in Lamongan Regency are tree theft and forest fires. The area of forest damage in 2016 increased from 197.6 Ha to 330.4 Ha (Lamongan Regency Government, 2016). The theft of trees in 2016 occurred in a forest area of 340 hectares. with a total of 1,689 trees stolen. The biggest theft occurred in November 2016. The loss due to the theft of the tree was estimated at Rp 1,073,444,000. With the increasing population, it is predicted that in 2014 there will be 1,348,259 people. Meanwhile, in 2015 there were 1,338,800 people. It is predicted that the percentage of population growth in Lamongan Regency will increase by 0.26%. With the population of Lamongan Regency which has increased and the number of residents is still high, this has the potential to cause pressure on the environment due to the activities carried out.

This massive destruction of mangrove forests will affect the food supply for coastal communities. Based on interviews, the coastal communities of Lamongan Regency have long used the Bruguiera mangrove fruit to mix their daily rice meal. This is because the need for basic food prices sometimes soars, so that people depend on this mangrove fruit. However, recently people have started having difficulty finding bruguiera mangrove fruit as an alternative food ingredient.Thus, the conversion of forest and agricultural land, as well as the frequent occurrence of forest fires are the main causes of the increasingly scarce mangrove bruguiera fruit for food supply.According to Pananto's research (2007) that

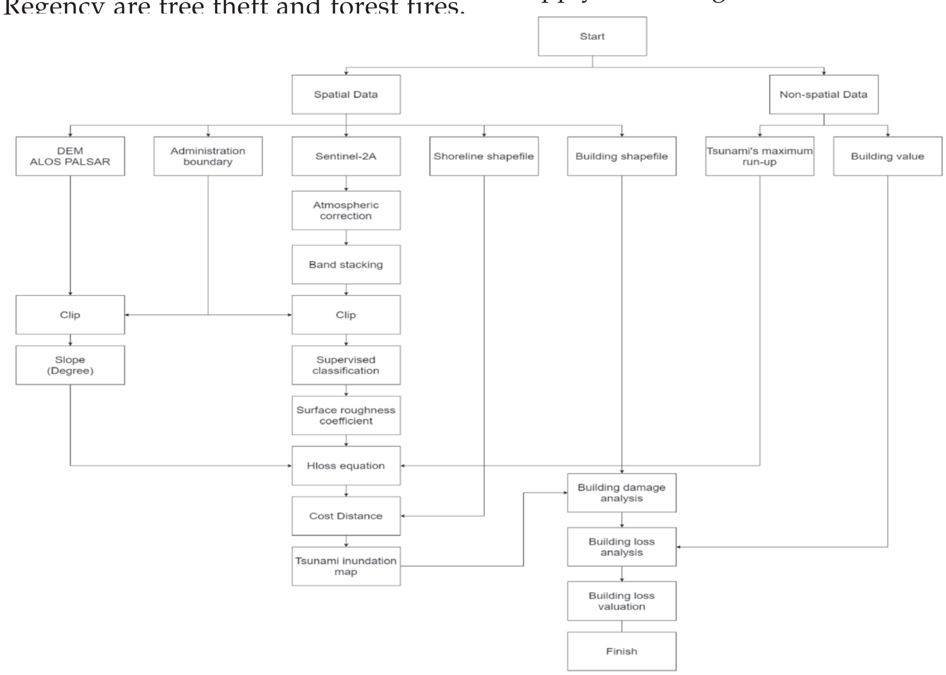

Fig. 2. Measurement of water quality in two villages in Lamongan district

in the research area in Paciran village and in Brondong village, the species found included: Bruguiera gymnorhiza, Rhizophora mucronata, Ceriops decandra, Aegiceras corniculatum, Sonneratia alba.

Study Method

To determine the quality of sea water, measurements were made at 4 stations spread across the research area. The measured seawater quality includes: temperature, salinity, pH. while the measurement of mangrove density using the Decree of the Minister of the Environment No. 201 of 2004 to determine the level of density.

NDVI

Normalized Difference Vegetation Index (NDVI) or Vegetation Index is an optical measurement of the greenness of the vegetation canopy, composite properties of leaf chlorophyll, leaf area, structure and canopy cover of vegetation (Huete *et al*., 2011). The vegetation index is used to obtain information on the density, biomass, and greenness of the vegetation. The NDVI vegetation index equation follows the equation (Rouse *et al*., 1974) as follows:

$$NIR = \frac{NIR - Red}{NIR + Red}$$

NIR = Near-Infrared (Infrared Channel)
Red = Red (Red Channel)

Use of remote sensing imagery to estimate mangrove cover and density. Extraction of information on the area and density of mangroves from remote sensing images is carried out in 3 stages, namely pre-image processing, image processing and post-image processing. In the image pre-processing stage, geometric and radiometric corrections are performed. Geometric correction is the correcting of the position of the image to match the actual coordinates on the face of the earth, while radiometric correction is the correction of the pixel values contained in the image so that it is free from bias that results in quantitative interpretation errors (Yudo and Farda, 2013).

In this study, geometric correction was not carried out in detail because the image used had been systematically corrected geometrically from the image data provider (vendor). This will be proven by overlaying the image on data in shapefile format (*.shp). If the image data has shown the suitability of the patching location, it can be said that the image has been geometrically corrected enough. In addition, checking the RMS Error value contained in the metadata is also carried out to ensure the geometric level of the image.

Radiometric correction is performed by converting pixel values from DN (Digital Number) format to reflectance values using the following formula:

$$4\rho\lambda' = M\rho Q_{cal} + A_{\tilde{n}}$$

Remarks:

rl = TOA planetary reflectance, without correction for solar angle.

M*r* = Band-specific multiplicative rescaling factor from the metadata

A*r* = Band-specific additive rescaling factor from the metadata

Q_{cal} = *Quantized and calibrated standard product pixel values (DN)*

GSCA

Meanwhile, to map the aspirations and assessment of the community regarding the existence of the Bruguiera gymnorrhiza mangrove species, it will be carried out using the GSCA model by taking 55 respondent as shown tabel below:

Table 1. Number and types of Respondents

No	Type of Respondents Lamongan Regency	Paciran Village	Labuhan Village
1.	Local People	15	15
2.	Local Government	11	5
3.	Private Sector	5	4
	Total	31	24

GSCA modeling is done by assessing the suitability of the measurement model (outer model). Convergent validity is assessed based on the value of the loading factor of each indicator forming the latent construct. A latent construct is valid or good if the estimated loading factor value is more than 0.5 (Ghozali, 2013). Discriminant validity is assessed by comparing the value of each latent construct with the correlation between the relevant variable and other variables in the model. If the AVE square root value of each variable is greater than the correlation value between the variables and other variables in the model, it can be said to have a good discriminant validity value (Ghozali, 2013). Here's the formula for calculating AVE:

$$AVE = \frac{\Sigma_{j=1}^{h} c_{ij}^{2}}{\Sigma_{j=1}^{h} c_{ij}^{2} + \Sigma_{j=1}^{h} (1 - c_{ij}^{2})}$$

Composite reliability measuring a latent construct can be evaluated with two kinds of measures, namely internal consistency and cronbach alpha. The recommended composite reliability value is greater than or equal to 0.7. Composite reliability can be calculated by the formula:

$$pc = \frac{(\Sigma_{j=1}^{h} c_{ij})^{2}}{(\Sigma_{j=1}^{h} c_{ij})^{2} + \Sigma_{j=1}^{h} (1 - c_{ij}^{2})}$$

In addition to looking at the value of pc, composite reliability can be done through hypothesis testing. The indicator is declared valid if the loading value has a significant CR value. The test is carried out as follows: Hypohesis:

H_0: cij = 0, i.e. loading indicator is not reliable

H_1: cij 0, i.e. loading of reliable indicators Test statistics:

H0 is rejected if the value of ｜CRl｜ 2.0 with an error rate of means the estimated loading value of each reliable indicator.

Structural model fit (inner model)

Structural model was evaluated by parameter significance test and R-square value. Parameter significance test is used to determine whether the coefficients of each exogenous variable significantly affect or not. Testing the significance of the parameters as follows:

Hypothesis: H0: = 0, that is the parameter coefficient is not significant

H1: 0, that is, the parameter coefficient is significant. Test statistics:

$$CRb = \frac{b_i}{SE\ (b_i)}$$

Test Criteria

H0 is rejected if the value of ｜CRb｜ 2.0 with an error rate of means the parameter coefficient is significant.

The R-square value is the square of the correlation that explains the proportion of variance in the endogenous variables described by the model (Hwang *et al.*, 2004). The R-square formula is as follows:

Test Criteria

H0 is rejected if the value of ｜CRb｜ 2.0 with an error rate of means the parameter coefficient is significant.

The R-square value is the square of the correlation that explains the proportion of variance in the endogenous variables described by the model (Hwang *et al.*, 2004). The R-square formula is as follows:

$$R^2 = 1 - \frac{\sum_{i=1}^{n} e_i^{\,2}}{n}$$

where, R2 is the R-square value, ei is the residual value of the i-th respondent and n is the number of data.

Overall goodness of fit

FIT is the proportion of the total variance of all endogenous variables described by a particular model (Hwang *et al.*, 2004). FIT is used to explain the mismatch between the model and the data. The value ranges from 0 to 1 where the greater the FIT value,

Table 2. The results of water quality measurements can be shown in the table below.

Station	Plot	Longitude	Latitude	Temperatur	Salinity	pH
Station 1	Plot 1	112°19’40.05"E	6°51’50.98"S	25.3	31.4	7.3
	Plot 2	112°19’39.45"E	6°51’50.99"S	24.6	33.5	7.2
	Plot 3	112°19’37.83"E	6°51’51.56"S	25.6	32.3	7.3
Station 2	Plot 1	112°19’27.23"E	6°51’54.51"S	26	33.3	7.1
	Plot 2	112°19’25.51"E	6°51’54.30"S	25.5	33	7.0
	Plot 3	112°19’24.57"E	6°51’54.33"S	25.3	34.3	7.0
Stasiun 3	Plot 1	112°14’15.21"E	6°52’20.86"S	25	35.3	7.0
	Plot 2	112°14’14.64"E	6°52’21.52"S	25.2	35	7.1
	Plot 3	112°14’13.69"E	6°52’21.73"S	25.6	32.6	7.1
Stasiun 4	Plot 1	112°13’59.68"E	6°52’24.00"S	24.6	35	7.2
	Plot 2	112°13’58.92"E	6°52’24.45"S	25.3	34	7.1
	Plot 3	112°13’58.32"E	6°52’25.00"S	25.5	33.3	7.2

the better the resulting model. The FIT measurement is a function of the sum of the squared residues between the model and the data. The FIT value is influenced by the complexity of the model, namely the more parameters, the greater the FIT value. The FIT value is very sensitive to the complexity of the model, so it is necessary to look at the adjusted FIT (AFIT) value. AFIT is used to compare models. According to Hwang and Takane (2004), the model that maximizes AFIT can be considered the best

Table 3. Mangrove Density Measurement Results in the Study Area

Station	Spesies	Density (ind/ha)			Total (Ind/ha)
		Tree	saplings	Seedling	
1	*Bruguiera gymnorhiza*	256	169	0	1065
	Rhizophora mucronata	198	142	0	
	Ceriops decandra	54	77	0	
	Aegiceras corniculatum	71	91	0	
2	*Sonneratia alba*	333	98	0	1237
	Bruguiera gymnorhiza	267	83	0	
	Aegiceras corniculatum	89	101	0	
3	*Rhizophora mucronata*	565	76	0	1461
	Bruguiera gymnorhiza	754	66	0	
4	*Bruguiera gymnorhiza*	676	112	0	2384
	Rhizophora mucronata	333	66	0	
	Sonneratia alba	654	543	0	

Table 4. Mangrove dominance index in the Study Area

No	Types of mangrove	Paciran Village		Labuhan Village	
		Dominance	Dominance Relative	Dominance	Dominance Relatif
1.	*Bruguiera gymnorhiza*	10186.15	59.48	6997.69	37.60
2.	*Rhizophora mucronata*	1696.82	9.91	9415.92	50.60
3.	*Ceriops decandra*	184.16	1.08	23.01	0.12
4.	*Aegiceras corniculatum*	2416.56	14.11	0.00	0.00
5.	*Sonneratia alba*	2641.72	15.43	2173.17	11.68
	T o t a l	**17125.40**	**100**	**18609.79299**	**100**

Table 5. Labuhan Village Mangrove Density Area Based on the NDVI algorithm

Year	Mangrove Rare Density	Density (Ha) Labuhan Village Medium Density	Total High Density	Wide
2015	6,55	3,14	23,3	32,99
2020	6,31	1,95	26,5	34,76

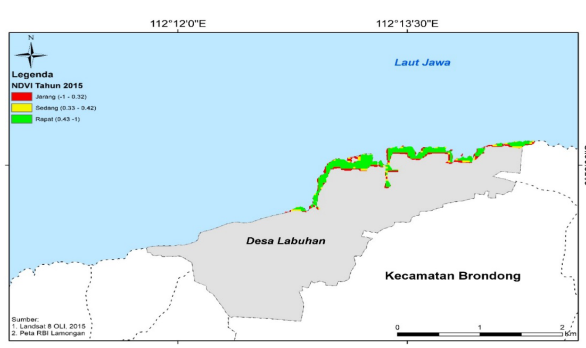

Fig. 3. NDVI Mangove Labuhan Map year 2015

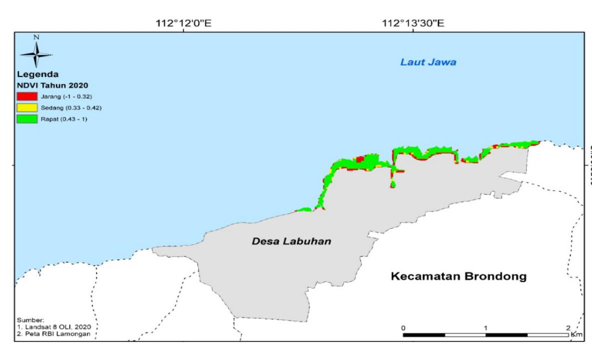

Fig. 4. NDVI Mangove Labuhan Map year 2020

model. The GFI value indicates the level of fit of the model estimate. According to Ghozali (2013), a good GFI score is more than 90%.

Results

The results of water quality measurements in Table 2 shows that the waters of Paciran and Labuhan villages are still not heavily polluted, and the condi-

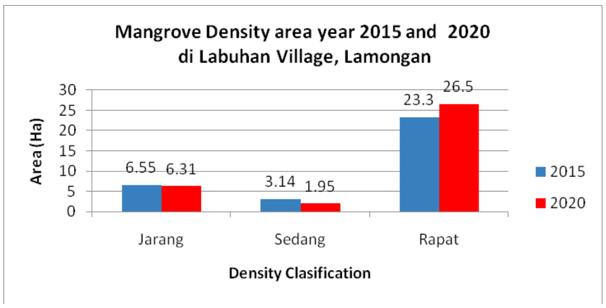

Fig. 5. Comparison of the Mangrove Density Area of Labuhan Village in 2015 and 2020

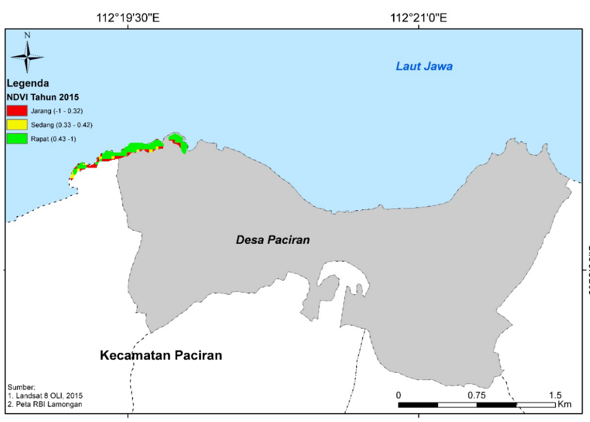

Fig. 6. NDVI Mangove Paciran Map year 2015

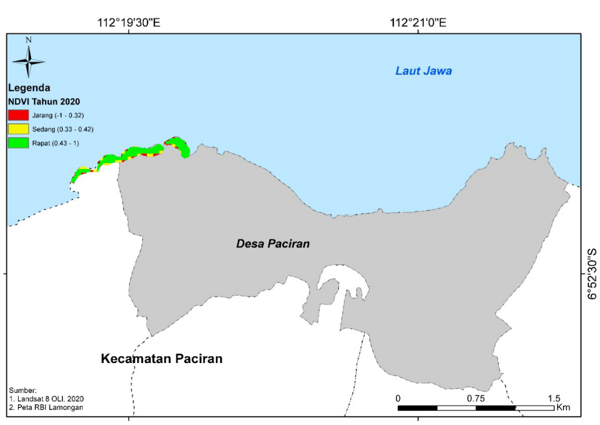

Fig. 7. NDVI Mangove Paciran Map year 20120

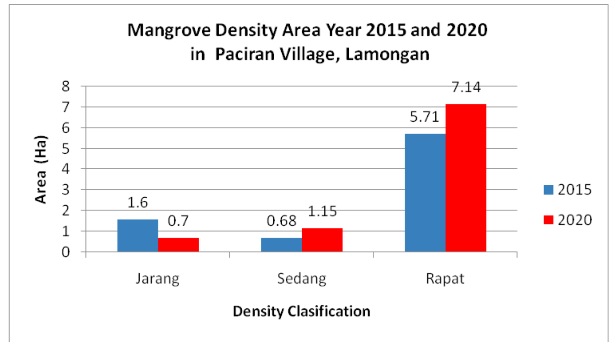

Fig. 6. Comparison of the Mangrove Density Area of Paciran Village in 2015 and 2020

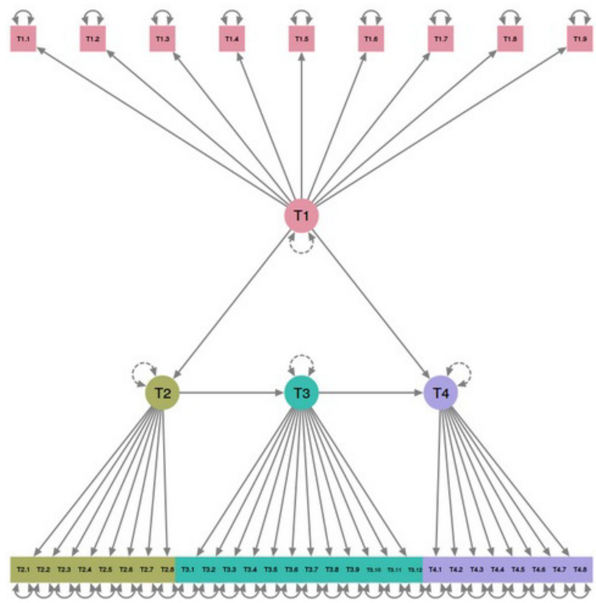

Fig. 7. GSCA Structural Model

tions for mangrove growth are still possible to grow well. Wheras, measurement of mangroves in the field can be shown in Tables 3, 4 below:

NDVI Analysis

The NDVI analysis produced a map of Labuhan Village in 2015 and 2020 as shown in Figure 3 and Figure 4 for Labuhan Village.

Based on Figures 3 and 4, the Mangrove Density Area of Labuhan Village was then compiled based on the NDVI algorithm, as shown in Table 5 below.

The NDVI analysis produced a map of Paciran Village in 2015 and 2020 as shown in Figure 6 and 7 for Paciran Village.

GSCA Analysis

The results of the GSCA analysis include: outer

Table 6. Labuhan Village Mangrove Density Area Based on the NDVI algorithm

Year	Mangrove Density (Ha) Paciran Village			Total Wide
	Rare Density	Medium Density	High Density	
2015	1,6	0,68	5,71	7,99
2020	0,7	1,15	7,14	8,99

Table 7. Objectives and its Variables

No	Objectives and its variables
1.	**Objective 1: Effect of Damage to mangrove ecosystems on food supply**
T1.1:	The community thinks that coastal damage is more caused by human activities
T1.2:	The community agrees to repair the damaged coastal environment by involving the community
T1.3:	The community hopes that the government and the community will make improvements based on a clear plan
T1.4:	The community hopes that the village government allocates village funds to repair mangrove forests in damaged coastal areas.
T1.5:	The community expects the provincial government to provide assistance to the community to carry out coastal restoration through mentoring funds
T1.6:	The community hopes that the use of mangrove forests as an alternative source of food will continue to be a concern
T1.7:	The community hopes that the damage to the mangrove forest will be resolved soon so that the community can use it as an alternative food source
T1.8:	The community observes that mangrove forests can be used as an alternative food source
T1.9:	The community agrees that the impact of damage to mangrove forests affects people's lives, both food and non-food
2.	**Objective 2: That the availability of food so far sourced from mangrove forests affects the food availability of coastal communities' households**
T2.1:	The community hopes to use the mangrove forest as an alternative source of food
T2.2:	The community observes that many communities use mangrove forests as an alternative source of food
T2.3:	Communities hope to be able to diversify food sourced from mangrove forests
T2.4:	The community hopes to provide guidance on the benefits and functions of mangroves as a food source
T2.5:	People know that people's consumption patterns have changed from basic food sources to alternative food sources
T2.6:	The community hopes that the community will immediately provide information to the community when the community no longer uses the mangrove forest
T2.7:	The community hopes that the community will look for alternative food sources other than in the mangrove forest
T2.8:	The community hopes that there is a pattern of using mangrove forests that can and cannot be used, so that the use of mangrove forests is sustainable
3.	**Goal 3: Access to food for coastal community households is highly dependent on mangrove forests**
T3.1:	The community is aware that the condition of the coastal ecosystem in the village has been severely damaged and will affect the community's access to use the mangrove forest
T3.2:	The community assumes that community access to use the mangrove forest is limited. This is due to the increasing destruction of mangrove forests due to human activities
T3.3:	The community thinks that to make it easier for the community to access the use of mangrove forests, it is to maintain and overcome coastal damage
T3.4:	The community assumes that to preserve the coast is not only the duty of the community but also the active participation of the community
T3.5:	Until now, the community does not have guidelines on how to overcome the damage to mangrove forestsT3.6: Communities need assistance from the Provincial Government to repair damaged mangrove forests so that they can recover
T3.7:	The community hopes that education on preserving mangrove forests needs to be taught in schools (SD, SMP, SMA)
T3.8:	The community agrees to prepare careful planning for the use of mangrove forests
T3.9:	The community agrees to involve the community in managing the mangrove forest

Table 7. Objectives and its Variables

No	Objectives and its variables
T3.10:	The community is able to provide problem solving to the community if the community has difficulty accessing food sources in the mangrove forest
T3.11:	The community is not able to provide problem solving to the community if the community has difficulty accessing food sources in the mangrove forest
T3.12:	The community encourages the community not to use mangrove forests as an alternative source of food
4.	Goal 4: That people's household food consumption is very dependent on mangrove forests
T4.1:	People think that people's consumption patterns have changed from basic food sources to alternative food sources
T4.2:	The community knows that the expenditure structure of the village community is currently more access to food sources in the mangrove forest
T4.3:	The village government needs to do careful planning to help the community find alternative sources of food, especially in mangrove forests
T4.4:	The village government hopes that the community can use the mangrove forest wisely so that food supply can continue
T4.5:	The community hopes that other sources of financing for coastal ecosystems can come from private CSR (Corporate social responsibility) funds
T4.6:	The community hopes that the community itself should manage the mangrove forest through POKMASWAS
T4.7:	The community does not yet have a program to repair damaged mangrove forests
T4.8:	The community has not thought about other alternative food sources to provide food for the community

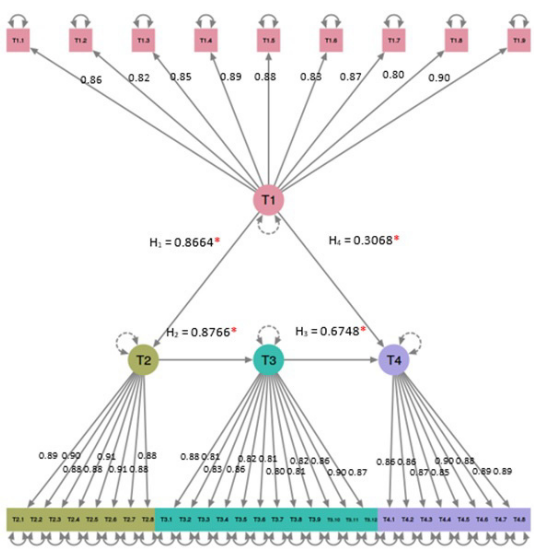

Fig. 8. GSCA Outer Model

model and Inner model and are detailed as follows:measurement of the model or Outer Model is done by looking at convergent validity, discriminant validity, and Internal consistency reliability.

The following are the results of the GeSCA calculations for Goal 1, goal 2, goal 3, and goal 4 onvergent validity results show that:

Objective 1: That the effect of damage to the mangrove ecosystem on food supply is real and significant at the 95% confidence level.Objective 2: That the availability of food so far comes from mangrove forests and affects the food availability of households in coastal communities is real and significant at the 95% confidence level.

Objective 3: That the household food access of coastal communities is highly dependent on mangrove forests is real and significant at the 95% confidence level.

Objective 4: That community household food consumption is highly dependent on mangrove forests is real and significant at the 95% confidence level.

The test of the inner model is divided into path coefficients and R square (R2). The results of the inner model test are used to test the research hypothesis. In testing the hypothesis, it is necessary to pay attention to the value of the path coefficients test. There are four hypotheses which are described in the four path coefficients. The following figure shows the results of the path coefficients test.

Hypothesis 1 (H1): Goal 1 has a significant effect on Goal 2: Goal 1 (Effect of damage to mangrove ecosystems on food supply) has a positive and significant effect on Goal 2 (that so far the availability of food sourced from mangrove forests affects household food availability for coastal communities), so hypothesis 1 (H1) is accepted.

Hypothesis 2 (H2): Goal 2 has a significant effect on Goal 3. Goal 2 (That food availability has been

Table 8. The Result of outer model for goal 1,2,3 and 4

Variabel	Loadings				
	Estimate	*Std.Error*	C.R.	95%CI_LB	95%CI_UB
Objectives1,2,3,4	AVE= 0.7485, *Cronbach's alpha*= 0.9579				
T1.1	0,8669	0,034	25,4971*	0.7736	0.911
T1.2	0,882	0,0289	30,5190*	0.7932	0.9244
T1.3	0,8521	0,0272	31,3272*	0.7851	0.9053
T1.4	0,8913	0,0291	30,6289*	0.825	0.9356
T1.5	0,8878	0,0193	46,00*	0.8494	0.9253
T1.6	0,827	0,0369	22,4119*	0.757	0.8959
T1.7	0,873	0,0227	38,4581*	0.8273	0.9146
T1.8	0,8008	0,0353	22,6856*	0.7372	0.8704
T1.9	0,9005	0,0223	40,3812*	0.8493	0.9407
T2.1	0,8897	0,0283	31,4382*	0.8246	0.9337
T2.2	0,9045	0,0212	42,6651*	0.8471	0.9417
T2.3	0,8762	0,026	33,70*	0.8179	0.9328
T2.4	0,8766	0,0328	26,7256*	0.7939	0.9213
T2.5	0,9125	0,024	38,0208*	0.8654	0.9568
T2.6	0,9148	0,0232	39,4310*	0.8627	0.9548
T2.7	0,8806	0,0287	30,6829*	0.8263	0.9363
T2.8	0,8767	0,0396	22,1389*	0.7611	0.9282
T3.1	0,8783	0,0284	30,9261*	0.8087	0.9274
T3.2	0,8139	0,0442	18,4140*	0.696	0.8852
T3.3	0,8298	0,0366	22,6721*	0.7689	0.9004
T3.4	0,8593	0,0336	25,5744*	0.7873	0.9043
T3.5	0,8195	0,0324	25,2932*	0.7503	0.882
T3.6	0,805	0,0338	23,8166*	0.7261	0.8617
T3.7	0,8029	0,0461	17,4165*	0.7065	0.8868
T3.8	0,81	0,0376	21,5426*	0.7212	0.8818
T3.9	0,822	0,0463	17,7538*	0.717	0.8973
T3.10	0,863	0,029	29,7586*	0.8003	0.9156
T3.11	0,902	0,0248	36,3710*	0.8434	0.9455
T3.12	0,8734	0,0324	26,9568*	0.8051	0.9289
T4.1	0,8696	0,0258	33,7054*	0.8199	0.9167
T4.2	0,856	0,0265	32,3019*	0.8103	0.9142
T4.3	0,8714	0,0251	34,7171*	0.8144	0.9172
T4.4	0,8471	0,0256	33,0898*	0.7916	0.8904
T4.5	0,9025	0,016	56,4063*	0.8674	0.9349
T4.6	0,883	0,0215	41,0698*	0.8383	0.9218
T4.7	0,8985	0,0218	41,2156*	0.8505	0.9349
T4.8	0,8955	0,0209	42,8469*	0.8525	0.9314

CR* = significant at 0.05 level

Table 9. Path Coefficient Results

	Estimate	*Std.Error*	C.R.
T2 ← T1	0,8664	0,0346	25,0405*
T3 ← T2	0,8766	0,0334	26,2455*
T4 ← T3	0,6748	0,084	8,0333*
T4 ← T1	0,3068	0,0865	3,5468*

sourced from mangrove forests affects household food availability for coastal communities) has a positive and significant effect on Goal 3 (Household food access for coastal communities is highly dependent on mangrove forests), so hypothesis 2 (H2) is accepted.Hypothesis 3 (H3): Goal 3 has a significant effect on Goal 4

Table 10. The Result of R Square

R-squared Values of Endogenous Latent Variables:	
T1	0,000
T2	0.7507
T3	0.7684
T4	0.8944

Goal 3 (Household food access of coastal communities is highly dependent on mangrove forests) has a positive and significant effect on Goal 4 (That community household food consumption is highly dependent on mangrove forests), so hypothesis 3 (H3) is accepted.Hypothesis 4 (H4): Goal 1 has a significant effect on Goal 4. Goal 1 (Effect of Damage to mangrove ecosystems on food supply) has a positive and significant effect on Goal 4 (That community household food consumption is highly dependent on mangrove forests), so hypothesis 4 (H4) accepted.

Based on Table 10 above, it is known that the R-square for the variable Objective 2: states that the availability of food so far sourced from mangrove forests greatly affects the food availability of coastal community households by 0.7507. This means that goal 2 related to the availability of food so far sourced from mangrove forests greatly affects the food availability of community households. This is influenced by Objective 1: The effect of damage to the mangrove ecosystem on food supply is 75.07%. While the other 24.93% are influenced by other factors.

The magnitude of the R-square value for the objective variable 3 is related to the food access of the coastal community's households is highly dependent on the mangrove forest. The value is 0.7684, which means that Goal 3: Access to food for coastal community households is highly dependent on mangrove forests which is influenced by Goal 2: That food availability so far has been sourced from mangrove forests affects household food availability for coastal communities by 76.84%. While the other 23.16% are influenced by other factors.

The magnitude of the R-square value for the goal variable 4 is 0.8944, which means that Goal 4 is related to the community's household food consumption that is highly dependent on mangrove forests. This is influenced by goal 1, namely the effect of damage to the mangrove ecosystem on food supply and goal 3, namely access to food for coastal community households who are highly dependent on mangrove forests by 89.44%. While the other 10.56% is influenced by other factors.Meanwhile, for Objective 1: The effect of damage to the mangrove ecosystem on food supply is an independent variable that affects the dependent variable, so it does not have an R square.

Based on the calculation of the FIT value, the variables that can explain the model are 0.7355. The FIT value provides information that the variables in Goal 1, Goal 2, Goal 3, and Goal 4 can explain the model by 73.55% and the remaining 26.45% can be explained by other variables not observed in this study.While the AFIT value is 0.725. This value is not much different from the FIT value so that it can support the conclusion on the FIT value. The AFIT value provides information that the variables in Goal 1, Goal 2, Goal 3, and Goal 4 can explain the model by 72.5%, and the remaining 27.5% can be explained by other variables not observed in this study.Wheras, Based on the calculation of the GFI value of 0.9988 which means that the overall model is very suitable because the GFI value is above 0.9 or close to 1.

Discussion

The results of the NDVI analysis stated that Labuhan village in 2020 had a high density of Bruguiera gymnorhiza mangroves from Ya'ang Labuhan beach to the villay Sty group location. Throughout this area, mangrove forests fortify rice fields from waves. Based on interviews from local residents that the expanse of rice fields is the result of land conversion from mangrove forests. In this regard, there needs to be a regulation from the local government not to convert the mangrove forest as a cultivation area. If the density of the mangrove forest cannot be maintained, then the coastal conditions of Labuhan will be bare from the attack of increasingly high waves due to climate change. Meanwhile, in Paciran village, mangroves were found, starting from the border of Paciran village with the port of Pengkolan, Kandang Semangkon village, continuing to the Intech seaside facility, Paciran village. In this area the mangrove forest also has a function to fortify rice fields and settlements, but the mangrove density varies, although from 2015 to 2020 it continues to shrink.

Based on the GSCA analysis, goal 1, namely the effect of damage to the mangrove ecosystem on food supply, has a positive and significant effect on Goal 2, namely that the availability of food so far sourced from mangrove forests affects the food availability of coastal communities' households. Thus, hypothesis 1 (H1) is accepted. Goal 2 related to the availability of food so far sourced from mangrove forests affects the food availability of coastal communities' households. This condition has a very positive and significant impact on Goal 3, which is related to household food access, coastal communities are very dependent on mangrove forests. Thus hypothesis 2 (H2) is accepted. Goal 3 related to household food access, coastal communities are very dependent on mangrove forests. This condition has a positive and significant effect on goal 4, namely that community household food consumption is highly dependent on mangrove forests. Thus, hypothesis 3 (H3) is accepted.

Goal 1 is related to the effect of damage to the mangrove ecosystem on food supply and has a positive and significant effect on Goal 4, namely that community household food consumption is highly dependent on mangrove forests. Thus hypothesis 4 (H4) is accepted.

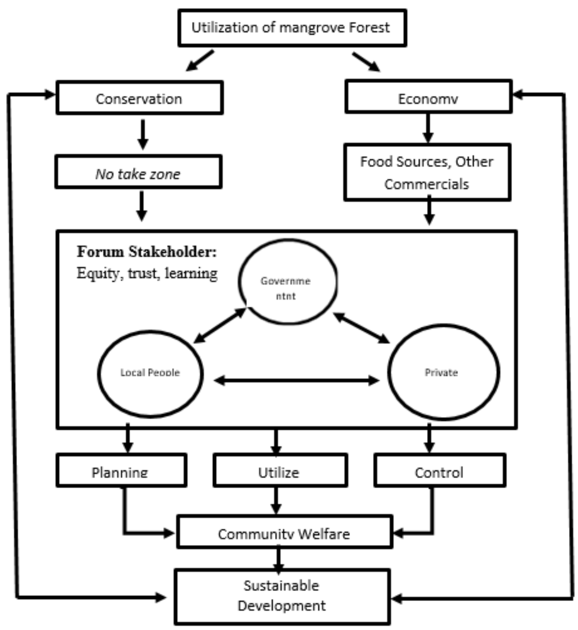

Fig. 9. Model of Mangrove Utilization Strategy Between conservation and economy

Overall, the analysis of the food needs of coastal communities on mangroves has a significant effect, so that if mangrove forests are damaged, it will also have a significant effect on community food availability. With the ease with which people use mangrove forests, the availability of food for the community is guaranteed, as an alternative food ingredient. In this regard, damaged coastal areas must be rehabilitated and restored to provide food for the community. Structuring the mangrove area is a must and the coastal area of Paciran village and Labuhan village, Lamongan Regency must be designated as a conservation area.

The prospect of mangrove forests in the future illustrates that if the policy statement from the regional government is to make the mangrove forest area a conservation area with a focus on providing food without damaging the mangroves. However, with the population of Lamongan Regency increasing, law enforcement becomes a priority.

To develop a strategy for structuring the area, it is carried out by combining the GSCA and NDVI (See Figure 9 above) processes related to the management of mangrove forests for food sources. The challenges faced in Paciran and Labuhan villages show that the management and utilization of mangrove forests for various anthropogenic activities must be carried out carefully 2. The initial conditions in the two coastal village areas show that their ecological conditions are already on the threshold of an "unhealthy ecosystem" environment.

Based on the considerations above, the concept of spatial planning in Labuhan and Paciran villages is structured as follows

a) Determination plan for the protection of mangrove forest areas in Lamongan Regency, covering mangrove forest areas in Brondong District, covering an area of approximately 12 ha in 2013. Currently, the results of field measurements in 2020 in Labuhan Village reach an area of 34.76 Ha. While the mangrove forest area in Paciran District in 2013 was approximately 13 ha. The results of field measurements of mangrove forests in Paciran Village are 8.99 Ha in 2020. In this regard, securing local protected areas along the coast is carried out by maintaining coastal ecosystems including: mangroves, coral reefs, seaweed and estuaries;
b) Increasing the economic value of protected areas through the use of mangrove forests and coral reefs as a source of fishery economy by means of environmentally friendly fishing and supporting sustainability;
c) Making protected areas as tourism objects and research on coastal ecosystems; and
d) Avoid opening new fishpond areas in mangrove forests.

Conclusion

The arrangement of mangrove forests in Labuhan village and Paciran village in Lamongan district using the GSCA and NDVI approaches shows the following results:

1. The results of the GSCA show that the *Bruguiera gymnorhiza* mangrove forest is an alternative source of food for local people that can be mixed with rice, and made various kinds of food diversification;
2. The NDVI results show that the mangrove density with the dominance of *Bruguiera gymnorhiza* species needs to be rehabilitated and restored to increase its density and density. Considering that the location of the mangrove forests in the two research villages is in water areas, it is necessary to have a policy to convert rice fields back to the growth of mangrove land.
3. The policy of the Lamongan district government which is contained in the strategic plan policy to optimize coastal land into the development of residential areas, industrial areas need to be updated and revised into protected areas.
4. Mangrove forest areas are managed for the use of mangrove forests as an alternative to food by dividing the area into a no-take zone and a limited economic area that can only be used as a food source area for the community.

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