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MANAGEMENT AND UTILIZATION OF MANGROVE FOREST TO INCREASE FOOD SECURITY OF COASTAL COMMUNITIES THROUGH MARINE SPATIAL PLANNING IN MALANG REGENCY AND PASURUAN REGENCY, EAST JAVA PROVINCE

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Abstract

Mangrove plants are an alternative source of food for coastal communities besides rice, corn, and sago. This research aims to determine the impact of damage to mangrove ecosystems that affect food availability in coastal areas. Besides this research also aims to determine the accessibility of the community to mangrove forests, because the community is very dependent on mangrove forests. The methods used to achieve these objectives are the Partial Least Square (PLS) method, Analytical Hierarchy Process (AHP) and Marine Spatial Planning (MSP). The results of this study showed that damage of the mangrove ecosystems had a significant effect on food supply in coastal areas, so that access to household food for coastal communities and consumption of household food is very limited. For this reason, the formulation of public policy related to food planning must be an important element in developing national guidelines.

Keywords*: Mangrove forests; Food supplies; Analytical Hierarchy Process; Partial Least Square; Marine Spatial Planning*

Introduction

The mangroves' physical location in the coastal zone transitioning between land and sea makes it a unique habitat. Mangrove forests are important to the coastal environment because of their physical, chemical, biology and economic functions, as well as their function of providing food for the community. Mangrove forests are very productive fisheries resources, and play an important role in capture fisheries, natural habitats for various species of fish and shrimp, and increase small-scale and commercial fisheries, although it is widely recognized that mangrove forests are starting to disappear quickly [1-4].

Ecologically, mangrove forests are among the most productive and biologically have a very important value for coastal communities, because they are not only as as nursery and the feeding areas but provide goods and services to coastal communities in the form of products such as fuel wood, building materials to build houses, build bridges, charcoal for medicines, fish habitat, and the important things [5-10].

Although mangrove forests provide various services to human needs, they are currently experiencing severe damage due to irrational use by humans in the form of pollution and environmental destruction.

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Food and Agricultural Organization in *The world's mangroves 1980–2005* [11] states that the current condition of mangrove forests shows that almost more than 50% of mangrove forests have experienced widespread damage due to irrational human activities. Around 1980, the total mangrove area in Southeast Asia had an area of mangrove forests reaching 6.8 million ha, which is about 34-42% of the total mangrove area of the world. However, by 1990 the mangrove forest area of Southeast Asia had fallen to less than 5.7 million ha. This decrease is around 15%, or more than 110.000ha per year. In 1990-2000, the mangrove forest area decreased to 79.000ha or decreased by around 13.8%. The largest mangrove area in Southeast Asia is found in Indonesia (almost 60% of total Southeast Asia), with Malaysia ranked second (11.7%), followed by Myanmar (8.8%), Papua New Guinea (8.7%) and Thailand (5.0%) [12].

As stated by [13] that excessive exploitation of mangrove forests in the southeast coast region of Bangladesh, has an impact on the loss of mangrove forests from 1903 to 2010. Thus, for 107 years the mangrove forests in this region were used irrationally. Even though the people in this area depend entirely on mangroves for their livelihoods. Thus, coastal communities have lost their livelihood choices including losing their food sources. Mangroves are a potential source of various food for all biota living in the mangrove ecosystems. The basic component of food chain in the mangrove forest ecosystem is not the mangrove plant itself but its litters. Some litters are decomposed by bacteria and fungi into dissolved nutrients that can be utilized directly by phytoplankton. Some areas produce particles (detritus) which are consumed by fish, shrimp, and crabs. The process of consuming in various categories and levels of biota forms a food path.

However, the mangrove crop is not the main food rather, it is for food diversification. In addition to reducing the consumption of staple foods (rice, corn, and sago), processed mangrove fruit in the form of flour can be used as a raw material for replacing flour as a source of carbohydrates. One of the various of mangroves is Bruguiera gymmorrhiza which a 19.66% carbohydrate content potential processed into flour. Pedada flour is used to substitute flour for making various kinds of snacks [14]. The nutritional content of mangroves includes high carbohydrate, fat, protein, and water content.

The purpose of this study was to determine the effect mangrove ecosystems on food supply in the coastal areas of Malang Regency and Pasuruan Regency. In addition, this study aims to determine the availability of food sourced from mangrove forests, including accessibility to mangrove forests to be used as daily needs.

To overcome the condition of mangrove forests that are increasingly damaged in the study area, the government must provide better understanding and awareness to the public about the benefits of mangrove forests as an alternative food source. For this reason, protection functions and efforts to increase the productivity of mangroves as well as the socioeconomic conditions of the mangrove ecosystem are important to do. Researchers asserts that mangroves have high carbohydrates so that they can be processed into flour, syrup, as an alternative food source [15]. This research will answer the question of how to manage and utilize mangrove forests to improve food security through marine spatial planning.

Experimental

Materials

This research is based on both primary and secondary data sources. The results of the two-month field survey are used for primary data collection covers interview and water quality measurements carried out twice at high tide at each mangrove density. Measurement of water quality to in Malang and Pasuruan districts in 2019. Primary data collection is done by interview through questionnaires. The target groups interviewed can be seen in table 1.

Table 1. Target groups interviewed when collecting primary data obtained through interview based on a questionnaire

No	Respondents	Location			
		Pasuruan regency (Sample size 60 respondents)		Malang regency (Sample size 60 respondents)	
		Penunggul (30 respondents)	Kalianyar (30 respondents)	Tambakrejo (30 respondents)	Lebakharjo (30 respondents)
1.	Local Governments	5	5	5	5
2.	Local people	5	5	5	5
3.	Private Sector	5	5	5	5
4.	Fishermen	8	8	8	8
5.	NGO	7	7	7	7
Total respondents		30	30	30	30

Besides conducting interviews with one of the target groups, namely local people, researchers also conducted interviews with the Community Monitoring Group (Pokmaswas) using the Forum Group Discussion (FGD) method. Pokmaswas are community groups that consolidate themselves to supervise mangrove forests voluntarily. This group was legalized by the Regent.

The FGD agenda is designed to focus on four agendas, namely: 1. The effect of damage to mangrove ecosystems on food supply; 2. Availability of food so far is it sourced from mangrove forests; 3. Household food access depends on the distance from the mangrove forest; and 4. Household food consumption is highly dependent on mangrove forests.

According to [16] water quality needs to be examined because it is very important for the continuation of ecological processes (nutrient cycle, environmental stability, and life support systems). Some chemical and physical factors observed in this study include temperature, acid-base (pH), salinity, and dissolved oxygen (DO). Effect of water quality on seedling growth is also important to study as a basis for optimization of seedling growth and the quality of the subsequent research environment. Whereas, variable water quality measured in Table 2.

Table 2. Water quality measured

No.	Water Quality Parameters	Pasuruan Regency		Malang Regency	
		Penunggul (Average)	Kalianyar (Average)	Tambakharjo (Average)	Lebakharjo (Average)
1.	Temperature (º)	28	28.6	25	25
2.	pH	7.8	7.9	8	7.5
3.	Salinity (º/oo)	32	10.2	26	32.2
4.	DO (mg/l)	4.1	5.9	6	4.9

To conduct data processing in the Marine Spatial Planning interpretation and mapping process of satellite imagery is poured into thematic maps. For this reason, materials are needed which include digital data on Landsat imagery for four districts of Pasuruan Malang and Malang District (Fig. 1). The Landsat image map was obtained from the United States Geological Survey (USGS). Besides that, an administrative map of the two regencies of 2019 is needed with a scale of 1: 50.000. After that the field survey was conducted.

The results of interpretation and field survey were communicated in the FGD forum about the decreasing area of mangrove forests. Mangrove vegetation density is one way to find out how closely a type of mangrove vegetation is in a place. Measurement of the density of mangrove species according to [16] uses the formula $Di = ni/A \times 10.000m^2$. Di is the density of species (ind/ha), for this is the total number of stands of species i and A is the total area of

sampling area (m^2). For the relative density of RDi types use the formula RDi = (ni/∑n) x 100. RDi is relative density, this is the total number and ∑n is the total stand of all species.

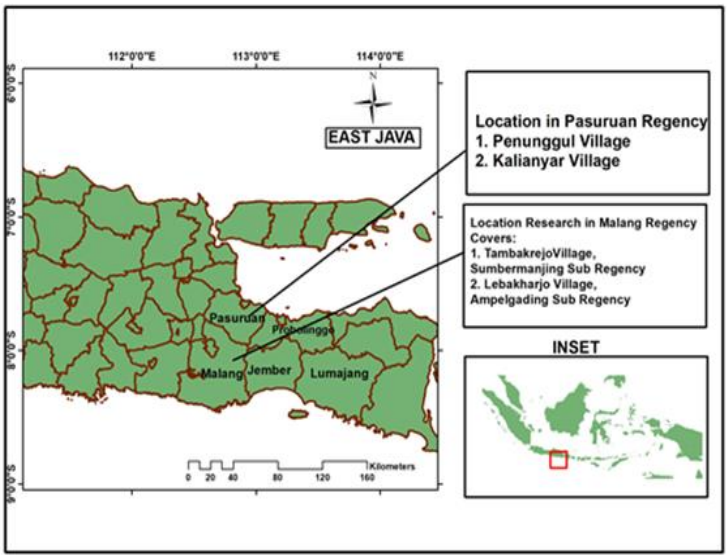


Fig. 1. Location Map of Site Research

The measurement results of mangrove vegetation density for the village of Kalianyar that the density of *Rhizophora Mucronata* 0.73 and the relative density of 73.68% and the density of *Soneratia Alba* 0.26 and the relative density of 26.32%. For the Penunggal village that the density of *Rhizopora Mucronata* is 0.72 with a relative density of 72%, for the density of *Avecennia mucronata* 0.20 with a relative density of 20%, and *Bruguiera cylindrica* 0.08 with a relative density of 8%.

The results of the measurement of the density of mangrove vegetation for Tambak Rejo village are that the density of *Rhizophora Apiculata* 0.36 and the relative density 36%. As for the *Ceriops Tagal* density 0.63 and the relative density 63%.

To find out the diversity of mangroves used the formula of Shannon's diversity index as follows: H' = - ∑[(ni/N) x ln (ni/N0],

H 'states the Shannon diversity index, Ni is the number of individuals of the i-th species and N is the total number of individuals of all species.

An important index value with the INP symbol shows that moderate diversity includes the distribution of the number of individuals in each of the categorized species. The stability of the community in the research area is also in the medium category. INP for three samples areas categorized stable. Especially for the Lebakharjo village, mangrove vegetation was not found.

Secondary data input comes from various publications from Government agencies, NGO reports and research organizations in Malang and Pasuruan Regencies. Food data and information collected are reorganized, analyzed, designed graphically and visualized through the use of PLS and AHP.

The PLS method is a multivariate statistical technique that can handle many response variables and explanatory variables. This analysis is a good alternative to multiple regression analysis and principal component regression, because this method is more robust. Robust means that the parameters of the model do not change much when new samples are taken from the total population. The results of the PLS analysis will present a set of policies on mangrove forest management as an alternative food source for coastal communities.

The results of the sustainability evaluation of the management of the mangrove forest ecosystem integrated with the results of the analysis of the condition of the ecosystem (ecological, economic and social) and subsequently carried out the Analytical Hierarchy Process (AHP) to formulate a sustainable mangrove forest management policy. Furthermore, multipurpose planning arranged with a policy approach to develop the marine spatial structure of the waters including:

1 Increasing access to mangrove ecosystem as an alternative source of food for the community;
2 Determination and improvement of the quality and access to the services that are integrated and purified with the use of other marine spaces, so that mangrove conservation can be restored through the restoration program;
3 Increasing the existence of an even and quality range of social services.

Results and discussion

Data processing for the results of interviews with stakeholders including FGD results was processed using AHP and PLS analysis. Furthermore, the results of water quality are used to determine whether water quality conditions support the current mangrove habitat. While the results of mangrove measurements are used to analyze the ability of mangrove provision as an alternative to providing food and food security.

Before executing the PLS and AHP models, it is necessary to identify the variable used in interviews with local government and fishing communities in the four study sites. These parameters show Table 3.

Table 3. Objectives and Indicators

No	Objectives to be Achieved	Indicators
1.	Objective 1: The Effect of mangrove's Ecosystem Damage To Food Supply (X1)	X1.1 Effects of mangrove ecosystems damaged on food supply
		X1.2 Mangrove Damage due to Human activity
		X1.3Mangrove damage needs to be restored
		X1.4 Mangrove damage is rehabilitated by the government
		X1.5 Need community involvement
		X1.6 The local government takes a lead to allocate funds
		X1.7 Mangrove forest as a food source for community
		X1.8 Sustainability of Mangrove forests as source of food
		X1.9 Community expectations are very great for mangroves as a food source
2.	Objective 2: Availability of community food sourced from mangrove forests (X2)	X2.1 The availability of food originating from Mangrove Forests affects the Coastal Communities
		X2.2 Sustainability of food availability in Mangrove Forests
		X2.3 Involvement of all stakeholders
		X2.4 Mangrove damage affects food production
		X2.5 Mangrove damage causes food production to decline
		X2.6 Using Mangrove Forests as source of food
		X2.7 The community aware of the effect
		X2.8 Collaboration between community and Govenment protect the Mangrove Forest
3.	Objective 3: Access to food Community Depends on Mangrove Forests (X3)	X3.1 Many communities use mangrove forests as a Food Source
		X3.2 Utilizing Mangrove Forests as a family food source
		X3.3 Maintaining the sustainability of Mangrove Forests
		X3.4 The importance of aspects for maintaining mangrove forests through a restoration program
		X3.5 Socialization to increase community awareness
		X3.6 The government provides technical guidance to the public
		X3.7 The importance of socialization for school children
		X3.8 Strict legal sanctions for offenders
		X3.9 Community participation for Sustainable Mangrove Forests

No	Objectives to be Achieved	Indicators
		X3.10 Determination of the mangrove zoning map
4.	Objective 4: Community food consumption is highly dependent on mangrove forests need to be diverted (X4)	X4.1 The pattern of community food consumption depends on the Mangrove Forest
		X4.2 The potential of mangrove forests as an alternative food source is the hope of the community
		X4.3 Current conditions show that mangrove forests cannot be used as a food source
		X4.4 Mangrove forests can be used as a variety of food sources
		X4.5 The poor use mangroves as a food source
		X4.6 Food sources have begun to shift to mangroves due to rising ce prices.
		X4.7 Food diversification shifts to Mangrove Forests
		X4.8 Mangroves as recommended consumption sources
		X4.9 The government needs to provide guidance to the public

Based on the table above, the PLS method performed first by testing the Outer Model. Outer model testing done by testing convergent validity, discriminant validity, and reliability of each observed variable (Table 4).

Table 4. Convergent Validity Results

	Original Sample (O)	Standard Error (STERR)	T Statistics (|O/STERR|)	P-value	Remarks
X1.1 <- X1	0.733	0.041	18.079	0.000	Valid
X1.2 <- X1	0.912	0.017	53.797	0.000	Valid
X1.3 <- X1	0.674	0.047	14.334	0.000	Valid
X2.1 <- X2	0.712	0.039	18.443	0.000	Valid
X2.2 <- X2	0.765	0.037	20.636	0.000	Valid
X2.3 <- X2	0.714	0.032	22.075	0.000	Valid
X2.7 <- X2	0.722	0.029	24.834	0.000	Valid
X3.5 <- X3	0.797	0.029	27.705	0.000	Valid
X3.6 <- X3	0.720	0.033	21.908	0.000	Valid
X3.7 <- X3	0.611	0.044	13.805	0.000	Valid
X3.11 <- X3	0.720	0.028	25.975	0.000	Valid
X3.12 <- X3	0.777	0.027	28.291	0.000	Valid
X4.1 <- X4	0.778	0.026	30.005	0.000	Valid
X4.2 <- X4	0.664	0.045	14.736	0.000	Valid
X4.9 <- X4	0.824	0.015	56.739	0.000	Valid

Source: Processed Research Data (2019)

The results of the convergent validity test on objective 1 namely "the effects of damaged to mangrove ecosystems damage on food supplies" obtained 3 valid indicators from 9 initial indicators used. Valid indicators include indicator X1.1, indicator X1.2 and indicator X1.3. These three indicators meet the convergent validity test requirements, which have a factor loading value of more than 0.500.

The results of the convergent validity test on objective 2 namely "the availability of food that has been sourced from mangrove forests affects the food availability of coastal households" obtained 4 valid indicators from the 8 initial indicators used. The valid indicators are indicator X2.1, indicator X2.2, indicator X2.3 and indicator X2.7. The four indicators meet the requirements for convergent validity test, which have a factor loading value of more than 0.500.

The results of the convergent validity test on target 3 namely "access to household food for coastal communities are highly dependent on mangrove forests" obtained 5 valid indicators from the 10 initial indicators used. These valid indicators are indicator X3.5, X3.6, X3.7, X3.9 and indicator X3.10 These five indicators meet the requirements of convergent validity test that have a factor loading value of more than 0.500.

The results of the convergent validity test on goal 4 that "household food consumption is highly dependent on mangrove forests" obtained 3 valid indicators from the 9 initial indicators used. Valid indicators are indicator X4.1, indicator X4.2 and indicator X4.9. These three indicators meet the convergent validity test requirements, which have a factor loading value more than 0.500.

Based on the results of the convergent validity tests on the 4 objectives, the next step is to conduct a discriminant validity test, with the following results in Table 5.

Table 5. Discriminant Validity Results

	AVE*) roots	**X1**	**X2**	**X3**	**X4**
X1	0.780		0.514	0.403	0.284
X2	0.729	0.514		0.531	0.439
X3	0.728	0.403	0.531		0.720
X4	0.758	0.284	0.439	0.720	

The discriminant validity test results obtained from the root value of AVE from each latent variable or destination variables are greater than the correlation between latent variables, so that it meets the requirements of the discriminant validity test (Table 6).

Table 6. Constructive Reliability Results

	Composite Reliability	Cronbachs Alpha
X1	0.821	0.648
X2	0.819	0.707
X3	0.848	0.776
X4	0.801	0.645

The construct reliability test results indicate that the Composite Reliability value of each latent variable is more than 0.70 and the Cronbachs Alpha value of each latent variable is more than 0.60. Thus, they meet the construct reliability requirements.

Inner Model and Hypothesis Testing

Testing the inner model calculated by testing the influence between latent variables (Table 7).

Table 7. Inner Model Results and Hypothesis Testing

	Original Sample (O)	Standard Error (STERR)	T Statistics (|O/STERR|)	P-value	Remarks
X1 -> X2	0.514	0.034	15.298	0.000	Significant
X2 -> X3	0.531	0.035	15.053	0.000	Significant
X3 -> X4	0.740	0.021	35.393	0.000	Significant

The results of the inner model and hypothesis testing (Fig. 2):

1. The influence of variable X1, namely "the effect of damage to mangrove ecosystems on food supply" to variable X2 "availability of food sourced from mangrove forests affects the availability of coastal household food" obtained path coefficient of 0.514 with a significance value of 0,000 ($p < 0.05$). This value is a significant positive effect, meaning that the higher the respondent's perception of variable X1 "the effect of damage to mangrove ecosystems on food supplies" will have a significant effect on respondents' perception of variable X2 "availability of food sourced from mangrove forests affects the availability of coastal household food".

2. The influence of variable X2, namely "the availability of food sourced from mangrove forests influences the availability of coastal household food" to variable X3 "access to household food for coastal communities is highly dependent on mangrove forests"

obtained a path coefficient of 0.531 with a significance value of 0,000 ($p < 0.05$). This value is a significant positive effect, meaning that the higher the respondent's perception of variable X2 "the availability of food sourced from mangrove forests influences the availability of coastal household food" significant effect on respondents' perception of the variable X3 "access to household food for coastal communities is highly dependent on mangrove forests".

3. The influence of variable X3, namely "access to household food for coastal communities is highly dependent on mangrove forests" to variable X4 "household food consumption is highly dependent on mangrove forests" obtained path coefficient of 0.740 with a significance value of 0,000 ($p < 0.05$). This value is a significant positive effect, meaning that the higher the respondent's perception of variable X3 "access to household food for coastal communities is highly dependent on mangroves" will have a significant effect on respondents' perception of variable X4 "household food consumption is highly dependent in mangroves".

4. The influence of variable X4, namely "household food consumption is highly dependent on mangrove forests" is obtained 3 valid indicators from the 9 initial indicators used. The valid indicator X 4.1 "I think the pattern of community food consumption also depends on mangroves", and indicator X4.2 "I think that the potential of mangroves can be a mainstay for the community as an alternative food source", as well as indicator X4.9 "I think the government needs to give the community the benefits of mangroves as an alternative food source." These three indicators meet the convergent validity test requirements, which have a factor loading value of more than 0.500.

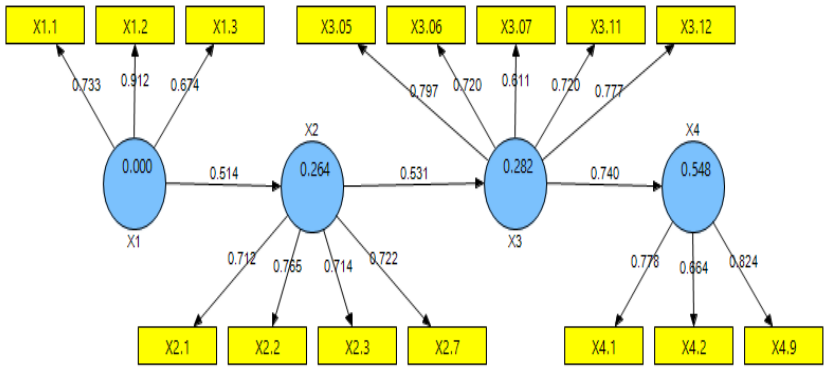


Fig. 2. Structural Model of PLS

AHP Results

Objective 1: The Effect of mangrove's Ecosystem Damage to Food Supply (X1)
X1.1 Effects of mangrove ecosystems damage on food supply (L: 0.60)
X1.2 Mangrove Damage Due to Human activities (L: 047)
X1.3 Mangrove damage needs to be restored (L: 088)
X1.4 Mangrove damage is rehabilitated by the government (L: 080)
X1.5 Need community involvements (L: 320)
X1.6 The local government takes a lead to allocate funds (L: 140)
X1.7 Mangrove Forest as food source for community (L: 137)
X1.8 Sustainability of Mangrove forests as source of food (L: 020)
X1.9 Community expectations are very great for mangroves as a food source (L: 109)

The first objective is to find out the public opinion about the effect of damage to mangrove ecosystems on food supply. The results of testing with AHP produce the highest value of 0.320. These results are shown in alternatives to the need for community involvement, so that community involvement is needed to reduce and mitigate damage to mangrove ecosystems for food supply.

Objective 2: Availability of community food sourced from mangrove forests (X2)
X2.1 The availability of food originating from Mangrove Forests affects the Coastal Communities Household (L: 118)
X2.2 Sustainability of Food availability in Mangrove Forests (L: 081)
X2.3 Involvement of all stakeholders (L: 246)
X2.4 Mangrove damage affects food production (L: 137)
X2.5 Mangrove damage causes food production to decline (L: 089)
X2.6 Using Mangrove Forests for food (L: 072)
X2.7 The community is aware of not damaging the mangrove forest (L: .088)
X2.8 Collaboration between community and government to protect the Mangrove Forest (L: 167)

The second objective to find out public opinion about the availability of food that has been sourced from mangrove forests and affects food availability. The results of testing with AHP obtained the highest value of 0.246, namely "the involvement of all stakeholders", so that in achieving these objectives requires the involvement of all stakeholders.

The third objective to find out public opinion about access to food. The results of testing using AHP obtained the highest value of 0.216. This value implies that a clear zoning determination is needed so that the disputed land can be clarified on map. Determination of zonation in mangrove forest areas will provide clear guidelines to determine the areas that can and should not be exploited.

Objective 3: Access to community food depends on Mangrove Forests (X3)
X3.1 Many communities use mangrove forests as a Food Source
X3.2 Utilizing Mangrove Forests as a family food source
X3.3 Maintaining the sustainability of Mangrove Forests
X3.4 The importance of aspects for maintaining mangrove forests through a restoration program
X3.5 Socialization to increase community awareness
X3.6 The government provides technical guidance to the public
X3.7 The importance of socialization for school children
X3.8 Strict legal sanctions for offenders
X3.9 Community participation for Sustainable Mangrove Forests
X3.10 Determination of the mangrove zoning map

Objective 4. Mangrove forests need to be diverted (X4)
X4.1 The pattern of community food consumption depends on the Mangove Forest (L: 121)
X4.2 The potential of mangrove forests as an alternative food source is the hope of the community (L: 047)
X4.3 Current conditions show that mangrove forests cannot be used as a food source (L:.063)
X4.4 Mangrove forests can be used as a variety of food sources (L: 072)
X4.5 The poor use mangroves as a food source (L: 113)
X4.6 Rice food sources have begun to shift to mangroves due to rising rice prices. (L: 125)
X4.7 Food diversification shifts to Mangrove Forests (L: 214)
X4.8 Mangroves as recommended consumption patterns (L: 128)
X4.9 The government needs to provide guidance to the public (L: 117)

The fourth objective is to determine people's perceptions about household food consumption depending on mangrove forests. The test results using AHP obtained the highest value of 0.214, namely "food diversification shifted to mangrove forests".

Based on AHP analysis, it was found that the availability of food sourced from mangroves affected the household food availability of coastal communities. In addition, access to household food for coastal communities is highly dependent on the distance of mangrove forests. Thus, the consumption of coastal household food is to mangrove forests. AHP analysis results show that the alternative source of food for coastal community's mangrove forests. When food prices rise and the ability of people declines, they must find alternatives to rice. The government must provide rational access to the community. While the results of the PLS analysis show that to provide rational access to the community to make mangroves as an alternative source of food by involving the community. Community involvement is needed to reduce and prevent damage to the mangrove ecosystem for food supply. Thus, the involvement of all stakeholders is needed. The solution before the government gives rational access to the community, the government determines zoning of space in the mangrove forest for which areas can be used and which should not be utilized. After the zoning map is determined, a diversification strategy for food then shifted to mangrove forests.

MSP provides guidelines on the use of mangrove forests as an alternative food that is functional. Thus, the local government together with the community can use mangrove forests in a rational way based on a map of the area that categorizes the areas that need to be conserved and areas that can be utilized for functional food sources (Table 8).

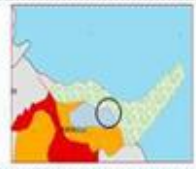
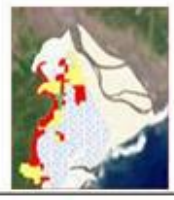
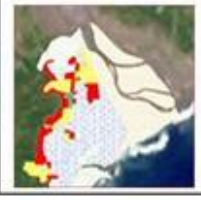
The picture bellow shows developments in each village showing that there was a drastic reduction in mangrove forests from 2012 to 2017. The decline in the area of mangrove forests was mainly due to the land being used for conversion to ponds, people's housing, ecotourism areas. The change of function according to the results of interviews with respondents is also caused by frequent land conflicts. This land conflict is a common symptom that occurs not only in the study area, but also in Indonesia and also in the Southeast Asia region.

Land conflicts that occur on the coast and irrational coastal exploitation have a significant impact on the reduction of mangrove forests, especially in Southeast Asia and Indonesia [17, 18]. The cause of damage to mangrove forests is indicated by the need for timber production for the mangrove reforestation project. While in Indonesia mangrove forest damage is almost 60% caused by Illegal logging. However, due to the occurrence of global climate change which resulted in extreme weather events threatening the lives of coastal communities, such as decreasing mangrove protection from storms and typhoons, declining mangrove functions as spawning sites, nurturing and breeding for fish biota, including threatening food security for coastal communities. The results of a study conducted by [17] stated that more than 90% of fishermen, wherever they are fishing, assume that mangroves provide protection from storms and typhoons and act as nurseries. Therefore, mangrove forests must be protected and restored. For this reason, mangrove replanting has a significant economic impact on the lives of coastal communities, especially for food security for coastal communities.

To improve and maintain mangrove forests as an alternative source of food, the priority that needs to be done is to manage fisheries food to increase the capacity of local communities to prepare management plans related to mangrove restoration. Whereas the second priority is that the government provides a policy and regulatory framework as a guide and support for improving the ability of mangroves as a food alternative [18].

According to [19] water quality is relatively influential on the density of mangrove species. The results of water quality measurements indicate that the mangrove area allows for the fluctuation of nutrients needed by mangroves. Water quality parameters are relatively influential on survival mangrove [20].

Table 8. Changing of mangrove forest in four sub district sample research area

No	Desa	2012	2017	2019	Remarks
1	Kalianyar Village, Subdistrict Bangil, Pasuran regency				Mangrove land is converted into ponds. In 2012 the area of mangrove land was 872.6 ha, then in 2017 the area decreased to 27.4 Ha, and in 2019 the mangrove area will be 52 Ha.
2	Penunggul village, Penunggul subdistrict Pasuruan regency				Mangrove land is converted into ponds. In 2012 the mangrove area was 14.2 hectares and decreased in 2017 by 8.5 hectares. In 2019 the area of mangroves will increase to 20.7 hectares
3	Tambakrejo village, Sumbermanjing Wetan subdistrict, Malang regency				Mangrove land is converted into ponds. In 2012 mangrove area was 95,7 Hectares and decreased in 2017 by 1 hectares. In year 2019 the area of mangroves will increas 26 Hectares
4	Lebakharjo village, Ampelgading sub district, Malang regency				In year 2012 until 2019 There is no mangrove forests due to unsuitable soil for planting mangrove. However the land is suitable for planting paddy.

The quality of the waters in the mangrove ecosystem is very affect the health conditions of mangrove plants, although these plants have a high adaptation to changes in salinity, these plants are also susceptible to changes in water quality such as temperature, pH, salinity and DO. The instability of these water quality parameters will result in a decrease in quality and even death in mangroves.

Changes in salinity that occur as a result of long tides are a limiting factor that affects the horizontal distribution of species. Mangroves can thrive in the tropics with temperatures of more than 20^{o}C with changes in average air temperature of less than 5^{o}C. Mangrove species of Rhizophora mucronata can tolerate a range of temperatures when compared with other types of mangroves. Mangroves grow in tropical areas where this area is affected by rainfall and affects the fresh water needed by mangroves.

Dissolved oxygen (DO) in the waters of Penunggul and Kalianyar and Tambakrejo ranged from 4.1 - 6.0mg/L. This condition is above the minimum threshold. The threshold according to [21] concerning environmental quality standards for DO is below 5. The solubility of oxygen in water is a function of temperature and salinity. Oxygen solubility is negatively correlated with temperature and salinity the waters.

The results of water quality measurements at sample locations in both Pasuruan and Malang districts indicate that the species of *Rhizophora mucronata* and *Ceriops tagal* are

suitable for growing with their habitat. The value of water quality in the sample location is in accordance with the threshold set by the government.

The measurement results of the Importance Value Index in both sample locations both in Pasuruan Regency with Rhizophora type in Pasuruan Regency and Ceriops Tagal type in Malang District indicate that both types of mangroves have potential as a source of food. *Rhizophora mucronata* can be used as flour. *Rhizophora mucronata* flour has a high calorie carbohydrate source with a high amylose content. weaknesses *Rhizophora mucronata* flour has a very high crude fiber content. Development is more directed at substitute products such as tannin (tea) extraction. Whereas Ceriops tagal contains tannin from the bark commonly known as a batik dye and also used as a drug for boils and women who have just given birth. The skin is also used as a betel meal mixture. Feather and fruit roots can be eaten even though they contain alkaloids [22, 23].

The condition of the use of mangroves for alternative supply and food security in research areas is almost similar to the study conducted by [24] by giving examples in Guinea that coastal land is very strategic to increase national food security by encouraging increased agricultural production based on increasing production focused on mangrove rice farming. Mangrove rice farming in question is using mangrove forest land to produce rice production. This is based on more than a third of Guinea's population living on coastal land. Mangrove rice farming is the use of mangrove forest land that has been cleared for rice production. According to [25] that mangrove rice cultivation represented 16% of the total rice planting area in Guinea.

The situation of mangrove vegetation in the study area can be further improved by mangrove restoration. Prior to 1982, the main objectives of mangrove restoration were greening for silviculture, coastal stabilization and environmental mitigation or remediation as an additional goal. Then, restoration is carried out to emphasize more on ecological values, sustainable use, animal habitats, food sources for pelagic fish food webs. Restoration is carried out to ensure the provision of food and the provision of livelihoods for coastal residents [26, 27]. Therefore, mangrove restoration program requires a clear mapping of its distribution through Marine Spatial Planning. However, the restoration of mangrove forests through rehabilitation efforts gradually increased the area of mangroves. This indicates that the role of government together with the people work together to restore mangrove forests. For this reason, the partnership program between the government and the community needs to be encouraged so that the area of mangrove forests grows, and the alternative functional food sources of mangroves can be increased. However, according to the results of the PLS and AHP analysis, the government needs to restructure the zoning system in the mangrove forest area to determine no take zone and take zone.

The important thing to determine zoning is to analyze the potential conditions that exist in both flora and fauna, including the future conditions. After that the government prepare and approve a space management plan with implement and enforce a consistent space management plan. To find out how effective planning has been, it is necessary to monitor and evaluate performance to adjust to the marine spatial management process.

Steps to formulate MSP were carried out with the government of Pasuruan and Malang Districts. The meeting was held with the Regional Development Planning Agency, the Fisheries Service, the Food Security Agency and the Social Service. The results of the meeting formed the basis for compiling the steps in preparing the MSP. They are including local government institution authorities responsible for MSP planning, financial support, restoration planning processes, organizing relevant stakeholder participation, ability to define and analyze current and future conditions, develop MSP plans, implement and strengthen MSP implementation, plans and adaptation processes MSP process. Details can be seen in the following Table 9.

Table 9. MSP Analysis

Step 1	Local Government (LG) Identify MSP needs and determine which Agency has the authority to plan MSP	• LG need MSP due to protec and conserve mangrove forest from degradation' • LG encourage local community to utilize mangrove as food sources, but it should be in line with government regulation; • LG need MSP to avoid land conflict; • LG need MSP to formulate licensing policy; • Appropriate authority for MSP is Regional Development Agency.
Step 2	Financial support	• LG will use the fund of Regional Revenue and Expenditures Budget; • Village government use their local budget to support mangrove rehabilitation and restoration; • Private sector contributes their fund through channelling fund called Corporate Social Responsibility (CSR).
Step 3	Organizing the process through pre-planning	• Organization of a marine spatial planning team that consisted of a team consisting of elements of government, society and representatives and the private sector called Local Team (LT); • A work plan that identifies key work products and resources required by LT to complete the outputs of planning on time; • LT together with Local Development Board Define boundaries & time frame for analysis based on collaborative management; • LT prepare a set of principles to guide development of the marine spatial management plan as well as to prepare a set of goals and objectives for the management area.
Step 4	Organizing stakeholder participation	• LT prepare a plan indicating who, when and how to involve stakeholders throughout the marine spatial planning process; • Stakeholders involved consist of representatives of the government, community and private sector; • The involvement of all stakeholders for coordination is based on their respective interests. However, it is expected to choose a time that each member can attend. • The involvement of the stakeholders is to resolve issues that arise in the community with each meeting making minutes of meeting and following up on every action plan that has been prepared and agreed upon.
Step 5	Defining and analysing existing conditions	• The local team made an inventory and compiled maps of potential related to important biological and ecological aspects in the marine management area; • Local teams compile an inventory of current human activities including compiling activities that put pressure on the marine management area; • Local teams assess possible conflicts and compatibility between existing human uses; • The local team conducted an assessment of possible conflicts and compatibility between existing human uses and the environment.
Step 6	Defining and analysing future conditions	• LT formulates a trend scenario illustrating how the MSP area will be realized if current conditions continue without intervention from new management; • LT also formulates alternative scenarios of spatial use of sea space that illustrate how marine and coastal management areas might look when human activity • redistributed based on new goals and objectives; and • LT must formulate a mutually agreed scenario as the basis for identifying and selecting management steps in the spatial management plan
Step 7	Developing a marine spatial plan	• LT should identify and evaluate of alterative management measures for the spatial management plan; • LT Identify of criteria for selecting alternative management measures; and • LT prepare comprehensive management plan, including a zoning plan.
Step 8	Implementin and Enforcing thae Spasial Management Plan	• LT should identify clear identification of actions required to implement, ensure compliance with, and enforce the spatial management plan.
Step 9	Monitoring and evaluating performance of the plan	• LT should prepare a monitoring system designed to measure indicators of the performance of marine spatial management measures; • LT should prepare Information on the performance of marine spatial management measures that will be used for evaluation; and • LT prepare periodic reports to regent as decision makers, including stakeholders, and the public about the performance of the marine spatial management plan.
Step 10	Adapting the marine spatial planning process	• LT prepare proposals for adapting management goals, objectives, outcomes and strategies for the next round of planning; • LT will identify of applied research needs.

The preparation of the MSP above requires a more comprehensive strategy after the MSP is prepared and formulated. The strategy broadly includes:

1) Zoning map that will be prepared, implemented and monitored and evaluated according to the MSP table above, needs to be equipped with various kinds of mangrove

utilization by the community. *J.M.W. Wibawanti and R.E. Mudawaroch* [28] state that one strategy for developing functional food products is to utilize mangrove fruits and leaves into a variety of food preparations. Functional food is food that provides positive effects in improving health, increasing endurance, slowing down the aging process and reduce the risk of certain diseases. For example, mangrove syrup that has a unique taste that is typical of fresh mangrove apple acids, contains vitamin C and antioxidants so that it can be used as a health drink. This is in accordance with [29] which states that mangrove apple syrup contains vitamin C as much as 50.1mg/100g syrup. The content of vitamin C is what functions as an antioxidant. Besides mangrove syrup also contains macro-nutrient components such as vitamins A, B1 and B2 [30]. There are four dimensions of food security, namely adequate intake, nutritional adequacy, the choice and feeling of food sufficiency, and the disruption of patterns food (food pattern disruption). Mangroves that are used rationally and balance between utilization and conservation will reach the intake [31].

2) The government must provide an alternative use of mangroves as an alternative food source. As [32] indicate that mangrove fruit processing is able to produce three products, namely Caseolaris syrup, candied Frutica and Jeruju tea bags. These three products are very potential for developed into superior alternative functional products. Utilization of this kind, which is called rational use, systematic use, directed and guided by environmentally sound development. Therefore, this research reinforces the statement by [33] that household food security is contested by three concepts, namely: food availability, food access and food utilization. Indicators that are often used in measuring household food security, namely dietary diversity, individual dietary intake, caloric acquisation (food availability) and indices of household coping strategy (indices of household coping strategy).

Conclusions

The results of this study indicate several findings, namely that the effects of damage to mangrove forests that are a mainstay of the community as a source of food supply require community involvement to restore damaged mangrove forests. For this reason, increasingly extensive mangrove forests have become a mainstay for the continued availability of community food. In this connection the stakeholders must be involved to conserve and conserve mangrove forests. Besides that, the community must be given access to utilize the mangrove forest, including preserving it. In this connection the role of mangrove zoning maps is needed as a basis for mangrove restoration, so that the economic goals of the community and the goals of mangrove conservation can be balanced. Therefore, the transfer of mangrove forests for other purposes must be avoided. Local governments must be firm in rejecting any permits that would divert mangrove forest functions.

Rhizophora Mucronata types that grow in Pasuruan and Ceriops tagal districts in Malang Regency are potential mangrove species as an alternative material for food and food safety. Therefore, it is necessary to expand food diversification by using both types of mangroves.

Rhizophora Mucronata types that grow in Pasuruan and Ceriops tagal districts in Malang Regency are potential mangrove species as an alternative material for food and food safety. Therefore, it is necessary to expand food diversification by using both types of mangroves. To keep mangrove well developed, the regional government must closely monitor water pollution through local regulations, including strict law enforcement.

The strategy of developing mangrove vegetation through MSP emphasizes the preparation of MSP steps with three important aspects, namely technical aspects of restoration, financial aspects and institutional aspects.

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