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Managing mangrove ecosystem restoration for fish supplies

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Key words: Managing mangrove restoration, Fishery Products, SWOT.

Abstract

The objective of managing mangrove ecosystem restoration is to increase the production of fish supplies using integrated coastal management. Mangrove ecosystem plays a significant role in replenishing various fish populations for the coastal. There are many benefits played by mangroves, especially in relation to increasing fish production. However, the destruction of mangrove forests around the world is very worrying, so that the provision of fish threatened to experience a very sharp decline. To examine the extent to which managing mangrove restoration is useful to increase fishery production, therefore, it is taken a case study in Pilang village located in Probolinggo regency, East Java province, Indonesia. The method used is descriptive method by measuring condition of mangrove, water quality as requirements habitat and field observation as well as spreading questionnaires and using SWOT analysis to develop effective strategies in managing restoring mangrove ecosystem. The study was conducted for 3 (three) months from March - June 2017 involving stakeholders, namely: coastal communities, private parties and the city government of Probolinggo. The results show that managing mangrove restoration should become public policy of Probolinggo local government, based on community participation and program preparation to support mangrove restoration.

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Introduction

IUCN (2006) mention that Mangroves are unique ecosystems occurring along the sheltered inter-tidal coastlines, mudflats, riverbanks in association with the brackish water margin between land and sea in tropical and subtropical areas. They sustain diverse flora and fauna species in large proportion and provide many ecosystem services such as coastal protection from storm, reduction of shoreline and riverbank erosion, stabilizing sediments and absorption of pollutants. Mangroves provide nursery grounds for fish, prawns and crabs, and support fisheries production in coastal waters. Almost every living things needs a safe place when it is young, small and fragile. Like human babies, young fish, shrimp, crabs and other animals in the sea need a safe place to grow, away from predators (Melana, *et al.* 2000). However. more than one in six mangrove species worldwide are in danger of extinction due to coastal development and other factors, including climate change, logging and agriculture, according to the first-ever global assessment on the conservation status of mangroves for the IUCN Red List of Threatened Species (IUCN, 2010). The Atlantic and Pacific coasts of Central America, where as many as 40 percent of mangrove species are considered threatened, are particularly affected. More than half of all mangrove forests have been destroyed in the past century, mainly by causes stemming from human development (FAO, 2008).

Mangrove forests cover more than 200,000 km2 of tropical and subtropical shelter in the world (Spalding, *et al.*, 1997). Mangrove forests disappear worldwide by 1 to 2% per year, a level higher than or equal to a decrease in nearby reefs or tropical rainforests (FAO, 2003). Losses are occurring in almost every country that has mangroves. An estimated 35% of mangrove forest area disappeared from 1980 to 2000 (MA, 2005), and faster mangrove forests decline than inland tropical forests and coral reefs (Duke *et al*, 2007). Seawater levels are relatively the greatest threat to mangroves (Gilman *et al*, 2008). It is predicted that 30-40% of coastal wetlands (IPCC, 2007) and 100% of mangrove forest (Duke *et al.*, 2007) may disappear within the next 100 years, if current losses continue.

Consequently, essential ecosystem goods and services (example: natural barriers, carbon sequestration, biodiversity, fish production) provided by mangrove forests will be reduced or lost (Duke *et al*, 2007).

The depletion of the mangroves of continental Asia have almost disappeared along the east coast of India, except in Bengal, and they have been depleted in most coastal areas in Thailand, Vietnam, The Philippines and many other Asian countries. With the exception of coastal Myanmar where ecological studies are scanty, an important collection of papers and books is now available related to the ecology of the mangroves of Asia at various ecological scales (Rao, 1987; Blasco and Aizpuru, 2000 in Blasco, *et al.* 2001). Whereas, the damage mangroves in Indonesia based on Richards *et al* (2016) showed that total mangrove in Indonesia has a total mangrove in 2000 covering an area of 2,788,683 ha. Then, it is experiencing deforestation of 60,906 Ha. Mangrove habitat is missing 48.025 Ha, so the percentage of mangrove that lost reaches 1.72%. However, mangroves are still being destroyed in many wetlands in Indonesia. the coastal lagoons remain the only sites where mangroves are still well-structured. But these mangroves are being intensively destroyed for firewood, housing, shrimp ponds.

The areas of mangroves in Indonesia vary from year to year. In 1978, it is estimated the extent of about 3.6-3.7 million ha (Snedaker, 1984., FAO, 1982., Burbridge *et al*, 1978). in 1982-1984, the mangrove areas ranging from 4.250-4.350 million ha (Soemodihardjo *et al.*, 1993., Darsidi, 1984., Cholik *et al.,* 1986). In 1993 and 1996 the extent of approximately is 2.40 million ha. (Giesen, 1993., Kitamura *et al.*, 1997). in 2000 the mangroves areas was 2.24 million ha (FAO, 2007), In 2009, BIG estimates of 3.244 million ha using 199 scenes of satellite images Landsat-7 ETM+ (Hartini, *et al.*, 2010). Based on the data above, it shows that the mangrove area decreases every year. The existence of mangrove forests in Indonesia has decreased in terms of quality and quantity from year to year.

In 1982, mangrove forest in Indonesia was recorded at 4.25 million ha, while in1993 it became 3.73 million ha, so in 11 years mangrove forest has been reduced by 0.52 million ha (Onrizal & Kusmana, 2008). Dahuri (2003) mentioned that the mangrove land use factor for aquaculture gives the largest contribution to the decline in the extent and damage of mangrove ecosystem in Indonesia. The importance of mangrove area to fishery productivity is by measuring the magnitude of the potential of the mangrove area by measuring the size of litter production. Mangrove forests with different density and closure conditions are estimated to have different values or effects on the surrounding environment.

Mangrove forests are unique habitats in their function as potential food source and nurseries, and support an important fisheries resource. Thayer *et al.* (1987) and Roberston *et al.* (1987) stated that mangrove provides shelters for most fish inhabiting the coastal zones and serves as nursery grounds for many species, such as shrimps and most commercial fish species. Fisheries success in many tropical coastal zones depends on mangrove health because they serve as spawning and nursery grounds for most species. Mangrove productivity is a source for fishery productivity in estuaries and nutrient contributors in nearby coastal waters (Boonruang, 1984). Mangrove plays a role in the chain of nutrient cycles for aquatic organisms (Kathiresan, 2001), so that management of mangrove ecosystem needs to be done so that the benefits provided by mangrove trees can be maintained and expected to increase productivity in the surrounding waters.Therefore, it should be strived that the management of mangrove forests should pay attention to the environment, because the role of mangrove forests in supporting fisheries activities is very real. Mangrove forests have important benefits for fish resources, mangroves as spawning, nursery and feeding for several types of fish resources. So that the existence and preservation of mangrove forests should be maintained so that the benefits provided can be optimized and protected from greater damage. Therefore, the management of mangrove forests needs to be done in an integrated and comprehensive manner, so that fishery productivity is maintained.

Thus, mangrove conditions with dense, medium and rare density will affect water quality and water fertility. As stated by Chongs (2007) that mangroves as nursery areas, and to coastal food chains and fisheries. The net fisheries contribution from 1 ha of mangrove forest amounted to US$846 yr–1. Various anthropogenic activities such as unsustainable forestry practices, aquaculture, coastal development, and pollution influence the carrying capacity of mangroves. To learn more about the effect of mangrove forest with the provision of fish, then it is conducted a case study in Pilang village, located in Probolinggo regency, east java province, Indonesia. There is indicated a decrease of mangrove area due to the anthropogenic process in the form of pond making and expansion. Based on the study report of mangrove forest potential of Probolinggo city (2007) that the mangrove area in Pilang village 0.77Km² (77 Ha), with a clean area for one year 0.03Km² (3 Ha), covering area of 0.8Km² (80 Ha). While in 2016, the area of mangrove in the village of Pilang reduced to 20.09 Ha (Wiyono, 2009). Meanwhile, according to the government of Probolinggo City (2016) the mangrove area of Pilang Village is currently 22.8 Ha. Reduced area of mangrove impacted to reduced fishery productivity.

The results of a study show that there is a significant linear relationship between shrimp production and mangrove size, expressed by the equation $y = 5{,}437+0{,}1128x$. Where y is the production of shrimp and x is the mangrove area. This relationship indicates that reducing tidal forests for industrial and agricultural purposes, would lead to a reduction in shrimp production (Martosubroto & Naamin, 1977 in Prahastianto, 2010). Loss of mangrove forests as litter producers will lead to early disconnection of food chains that have an impact on fish population decline.

Given the potential of natural resources in the village of Pilang is a pond. Then, the production of aquaculture and nonaquaculture will be the focus of this research. According to Rifai (2015) that the pond is used for the cultivation of milkfish and vaname shrimps. Mangrove plants can make the quality of ponds increased.

This is because mangroves are able to provide protection from coastal abrasion currents as well as breeding grounds for natural fish food. According to research Rifai (2015) that the existence of mangrove plants to be one of the success factors ponds in the village Pilang. Beach abrasion becomes a concern for fish farmers. Therefore, the planting of mangroves in ponds is considered as a form of tough dam to facilitate the flow of sea water and avoid the danger of abrasion. This method makes the cultivation of ponds considered successful. The purpose of this research is to formulate the strategy of managing restoration of mangrove forest to increase the production of fishery both cultivation and non-cultivation.

Materials and methods

Data Collection

This research uses mangrove restoration management approach. The data used to find out how far the destruction of mangrove forest, it is necessary data related to the composition of mangrove stands, the distribution of mangrove forest, type and density of mangrove trees, data mangrove density tree type, belta and seedling. In addition, it is necessary to measure for Dissolved Oxygen (DO), pH, salinity and temperature at 6 sample stations. To understand the management of mangrove forest restoration, it is necessary to interview 25 respondents whose type and number can be seen in table 1 below:

Table 1. The number and type of respondents.

Types of Respondents	Number of respondents
1. Community around Pilang village	10 Person
2. Community groups of supervisors from Pilang village	3 Person
3. Probolinggo City development planning agency	2 Person
4. Department of Marine and Fisheries	2 Person
5. Forestry Department	2 Person
6. Environment Agency	2 Person
7. Sub-district apparatus	2 Person
8. village officials	2 Person

For data collection of fishery production in Pilang village, it is conducted by using interview method and questionnaire.

Collection of fish production is only done for the production of cultivated fish and non cultivation which is a commodity that is caught along the waters in Pilang village around the mangrove area. In this study, it is using spatial approach that is observing the existence of mangroves in total Pilang area by analyzing the presence of mangrove in the area of cultivation (ponds) and non-aquaculture areas. The reason for using this approach because the restoration approach requires restoration of coastal habitats is to reverse the impact of pressure to the ecosystem and restore damaged habitat to conditions that reflect actual natural conditions. Improvements to coastal environmental conditions include: increased primary production, more natural tidal patterns, better water quality, and larger fish products and increased wildlife populations. Coastal restoration thus provides an opportunity to ensure long-term coastal health, including climate change adaptation (Abt Associates, 2014). In this research, it does not use litter research approach on the grounds that it is necessary first a "concept" to increase fishery production through restoration approach. If the "concept" has been found it is technically easy to investigate further by optimizing the role of mangrove ecosystems to the production of both cultivation and non-aquaculture. However, measurements of mangrove density are still required. For that purpose used measurement Ramaniya (2017) and Rani (2017) in Pilang village as shown in Fig. 1 below.

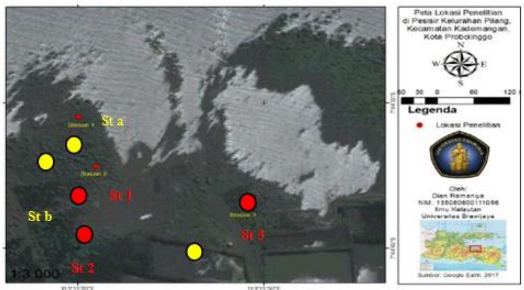


Fig 1. Research Station Location.

Ramaniya research station (Station 1,2,3): station 1 is directly adjacent to the beach; station 2 is located some distance from the beach; station 3 is located close to the river. Research station Rani (Station a, b, c) location a: get the influence of cold lava flows of Bromo mountain at low tide; location b: the influence of cold mountain lava flows of Bromo at the highest receding; location c: near river flow.

SWOT analysis

The use of SWOT analysis is a simple instrument in determining strategies to achieve goals. SWOT helps provide realistic direction of direction and focus on a particular part. SWOT analysis begins by taking into account every aspect of the research object.

These aspects include strengths, weaknesses, opportunities, and threats. The function of SWOT analysis is to get information from the situation analysis. Based on these analyzes then separated into internal factors (strengths and weaknesses) and the most important external factors (opportunities and threats) in the organization. This analysis is based on logic that can maximize the strength and opportunities but can simultaneously minimize the weaknesses and threats (Rangkuti, 1997).

To restore mangrove forest conditions at the site, it is necessary to restore mangroves as a solution to prevent further damage to mangrove forests, and to restore mangrove forests as they once were, even though they are difficult to achieve.

Results and discussions

Location of the project

Probolinggo city is located in East Java Province with an area of 56,667km2. Administratively, the city of Probolinggo is divided into 5 sub districts and 29 sub-districts consisting of Mayangan Sub-district. There are 5 sub-districts in Kademangan sub-district. There are 6 sub-districts, Wonoasih Sub-district, 6 Sub-districts, Kedopok District, 6 Sub-districts, and Kanigaran Sub-district. One of the sub-districts that have coastal area is Pilang village, Kademangan sub-district.

Description of mangrove on the study areas

Kelurahan Pilang has a total area of 306.8 Ha, where along the coast of Pilang Village is a lot of mangrove forest found both natural and re-planting. According Sundari (2016) that mangrove forests in Pilang Village in 2010 affected by eruption of Mount Bromo.

The cold lava disaster that brought volcanic ash from Mount Bromo has damaged mangroves in Pilang Village about 2 hectares. Refilian (2017) showed that Rhizopora mucronata has a composition of 66.17% in Pilang Village. For more details can be seen in table 2 below.

Table 2. Composition Upright Mangrove in Pilang Village.

No	Family	Species	n	Composition (%)
1.	Avicenniaceae	*Avicennia alba*	34	12.64
2.		*Avicenia marina*	15	5.58
3.		*Avicenia* sp	18	6.69
4.	Rhizophoracea	*Rhizophora mucro nata*	178	66.17
5.		*Rhizophora* sp	19	7.06
6.		*Rhizophora stylosa*	2	0.74
7.	Sonneratiaceae	*Sonneratia alba*	3	1.12
	Total		269	100

Source: Refilian (2017).

The results of Wiyono's (2009) study in Table 3 below reinforce the results of Rani's (2017) study which shows that the Important Value Index (INP) for Rhizophora Mucronata is higher than that of Nypa fruticans. Important value indexes are obtained from the accumulation of relative density, relative frequency, and relative closing values indicating the role of mangroves in maintaining coastal preservation belonging to medium category (Range 0-300).

Table 3. Distribution of Mangrove in Pilang Village.

No	Local Name	Scientific name	The number of Individuals in sample plot				Density	Relatif Density	Frequency	Frequency Relative	Important Value Index
			1	2	3	4					
1.	Bakau	*Rhizophora Mucronata*	52	78	99	212	311	93,96	4	66,67	160,62
2.	Nipah	*Nypa fruticans*	0	0	7	13	20	6,04	2	33,33	39,38
	Total		52	78	106	225	331	100	6	100	100

Source: Probolinggo Mangrove Forest Tourism Potential Study Report, 2007 in Wiyono (2009).

Remarks:

Plot 1= mangrove area with density 0-25% (Habitat around: rice field, ponds, river)

Plot 2= mangrove area with a density of 26-50% (Habitat around: ponds, rivers, settlements)

Plot 3= mangrove area with density 51-75% (Habitat around: unused land, river)

Plot 4= mangrove area with density 76-100% (Habitat around: unused land, river)

According to Wiyono (2009), the intensive degradation of mangrove forests in Pilang sub-villages resulted in coastal erosion impacts that caused damage to natural habitats of fish and shrimp, increased sea-water intrusion into the mainland and affected coastal people's livelihoods. The further development of the existence of mangrove forests is increasingly shrinking, especially in *Rhizopora mucronota* type. Both in pond areas, rivers, and paddy fields.

Research from Ramaniya (2017) showed that the type and density of mangrove in Pilang urban village for *Avecenia alba, Avecenia marina, Rhizopora mucronata and sonneratia alba* at station 1, 2 and station 3 were varied, where at station 3 the density was very dense compared to station 2 and station 1. In table 3 shows the type and level of density of mangrove tree species in Pilang village.

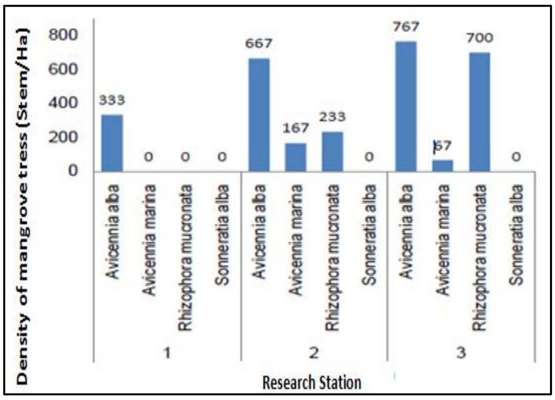
Table 4. Type and Density of Mangrove Tree Types in Pilang Village

Station	*Types*	Density Types (Di) Stem /ha	Relatives Density	Total Density	Level of density
1	*Avecenia alba*	333	100	333	Rarely *)
	Rhizopora mucronata	0	0		
2	*Avecennia alba*	667	62,5	1067	Medium *)
	Avecenia Marina	167	15,6		
	Rhizopora Mucronata	233	21,9		
3	*Avecenia alba*	767	50	1533	Very Solid *)
	Avecenia marina	67	4,3		
	Rhizopora mucronata	700	45,7		
	Soneratia alba	0	0		

Source: Ramaniya (2017).

Remarks:

*) Based on the Minister of Environment Standard No. 201 of 2004 on the criteria of mangrove damage.



Source: Ramaniya (2017).

Fig 2. Mangrove Density Diagram in Kelurahan Pilang.

For more details, research from Rani (2017) shows that observation at station (a) are 51 Stem/300m^2 which consists of 23 trees/300m^2, 17 belta /75m^2, and 11 seedlings/3m^2. At station (b) there are 144 Stems/300m^2 consisting of 101 trees/300m^2, 24 belta/75m^2, and 19 seedlings/3m^2. Further on station (c) there are 74 Stem/300m^2 consisting of 35 trees/300m^2, 34 belta/75m^2, and 5 seedlings / 3m^2. Based on 9 observation plots at tree, belta and seedling levels as a whole observed in Pilang sub-district, it was found 159 trees/900m^2 (1,767 trees/ha), 75 belta/225m^2 (3,333 belta/ha), and 35 seedlings/9m^2 (38,889 seedlings/ha). The mangrove community in Pilang sub-district is categorized as good with very solid criteria of 1.767 trees/ha which refers to Minister of Environment Decree no. 201 Year 2004.

Table 5. Result of calculation of mangrove density in Pilang Village.

Station	Types	Trees Number (Stem)	Trees Density (Stem/ Ha)	Trees Density relatives (%)	Belta number (Stem)	Belta Density (Stem/ ha)	Belta Density Relatives (%)	Seedling Number (Stem)	Seedling Density (Stem/ ha)	Seedling Density Relatives (%)
a	*Avecenia alba*	9	300	39	-	0	0	1	3333	9
	Avecenia marina	1	33	4	1	133	6	2	6667	18
	Avicenia sp	-	0	0	-	0	0	7	23333	64
	Rhizopora Mucronata	12	400	52	16	2133	94	-	0	0
	Soneratia Alba	1	33	4	-	0	0	1	3333	9
Total		23	766	100	17	2267	100	11	36667	100
b	*Avecenia alba*	11	367	11	-	0	0	3	10000	16
	Avecenia marina	2	67	2	5	667	21	-	0	0
	Avecinia sp	-	0	0	-	0	0	11	36766	58
	Rhizopora Mucronata	86	2867	85	-	0	0	5	16667	26
	Rhizopora sp	-	0	0	19	2533	79	-	0	0
	Rhizopora stylosa	2	67	2	-	0	0	-	0	0
Total		101	3367	100	24	3200	100	19	63333	100
c	*Avecenia alba*	5	167	14	5	667	15	-	0	0
	Avecenia marina	-	0	0	2	267	6	2	6667	40
	Rhizopora Mucronata	30	1000	86	27	3600	79	2	6667	40
	Soneratia alba	-	0	0	-	0	0	1	3333	20
Total		35	1167	100	34	4533	100	5	16667	100

Source: Rani (2017).

Water quality

To determine the survival of mangrove forest ecosystems required measurement of water quality parameters as shown in table 6 below. Based on table 6 above in both Ramaniya (2017) and Refilian's (2017) study the mean temperature values indicate that the water temperature is expressed outside the tolerance limit. This is in accordance with the decision of the minister of the environment no. 51 of 2004 which is 28°C - 32°C. This is influenced by a relatively shallow depth of measurement and measurement time.

Table 6. Result of Measuring Quality of Pilang Village Waters.

Stations	Water Quality Parameter DO	pH	Salinity	Temperature
a *)	6.04 ± 1.01	7.48 ± 0.03	24.33 ± 0.58	35.00 ± 1.87
b *)	6.26 ± 1.06	7.77 ± 0.01	26.67 ± 0.58	34.70 ± 1.40
c *)	6.26 ± 1.19	7.53 ± 0.06	21.00 ± 3.46	35.20 ± 1.20
Average	6.05 ± 1.09	7.59 ± 0.03	24.00 ± 1.54	34.97 ± 1.49
Quality Standard	➢ 5 mg/l	7 - 8,5	s/d 34‰	28°C - 32°C
Stations	**Water Quality Parameter DO**	**pH**	**Salinity**	**Temperature**
1**)	5,7	7,46	29	36
2 **)	5,4	7,13	25,7	33,7
3**)	6	7,32	25	31,9
Average	5,7	7,3	26,57	33,87
Quality Standard	➢ 5 mg/l	7 – 8,5	s/d 34 ‰	28 - 32

Source: Revilian Al Rani (2017)*) and Ramaniya (2017)**).

The average value of salinity parameters in coastal waters of Pilang village is 24 per mile and includes a water pH value of 7-8.5 and the average chemical parameter value of DO is 6.17mg / L. All of these parameters are still within the limits of tolerance according to the decree of the State Minister of Environment No. 51 of 2004.

Besides, mangrove litter contributes to the production of both aquaculture and non-aquaculture fisheries. Litter is the dead material of vegetation, so it falls to the surface of the soil and then decomposes and mineralization. Components including litter are leaves, twigs, small branches, bark, flower, and fruit (Mindawati and Pratiwi in Aprianis, 2011).

Leaf litters

Leaf litter as the primary productivity of mangroves is an important source of carbon in the process of decomposition. The quality and quantity of litter on an ecosystem will have an effect on increasing the catabolism of decomposing organisms (Dharmawan, 2016). Falling litter will experience the decomposition process by microorganisms into litter. The flow of energy produced by mangrove forests is a source of nutrients for organisms. Litter in the process of decomposition becomes a highly nutritious food source for various types of aquatic organisms (especially detritifors) which can then be utilized by high organisms in the food webs (Zamroni *et al*, 2007). Based on the result of litter measurement of stations a, b, and c are as follows:

a) Station a: Avicenia Alba 3.19 ton/ha/year, Avicenia Marina 11,23 ton/ha/year, Rhizopora mucronata 8,53 ton/ha/ year, so total 22,95 ton/ha/year.
b) Station b: Avicenia Alba 1.72 tons/ha/year, Avicenia Marina 8.23 tons/ha/year, Avicenia Alba 3.40 tons / ha / year, Avicenia Marina 6.43 tons / ha / year, bringing total 19 , 78 tons / ha / year
c) Station c: Avicenia Alba 1.61 ton/ha/year, Avicenia Marina 1.75 ton/ha/year, Rizhopora mucronata 7.96 ton/ha/year, Sonneratia alba 9,24 ton/ha/year, bringing the total to 20,56 tons/ha/year.

Based on tables 4 and 5 above, it is characterized by the absence of complete mangrove zonation in the Pilang region. Most litter production was found in station I with amount 34,701g/m^2/ week while the lowest litter production was at station III that was 34,023 g/m^2/ week. The differences obtained for each station are due to differences in the density, age of the plant, and the fertility that can indirectly affect.

According to Soenardjo (1999) the older the plant the litter production decreases, and vice versa. In addition to these factors leaf morphology also affects litter production.

Production of litter is a major supporter of fisheries potential, from a small leaf litter production carried by the current and mostly fixed on land or in the forest. Leaf litter left on land becomes animal food and most will experience partial or complete decomposition by microorganisms and bacteria. It means that the higher the production of litter, the higher the productivity in the mangrove forest. Therefore, it can preserve the existence of mangrove and it can increase the potential of fisheries in the area. The more litter produced in a mangrove area the more litter is produced. Litter is the source of high nutritious food for various types of aquatic organisms (especially detritifors) which can then be utilized by high-level organisms in the net of food webs (Ramli, 2012). Further research Rani mentions that mangrove leaf litter contribute significant energy to the ecosystem or surrounding environment and support coastal fisheries. This proves Chong (2007) study that mangrove contribute substantially to coastal fisheries in terms of providing trophic and refuge support, and larval retention.

Rani's study concluded that the heavy production relationship of mangrove leaf litter contributed significantly to the weight of herbivore fish in each ecosystem with a correlation value> 0.97. This is except the coral reef ecosystem. Mangrove forest degradation contributes significantly to the decline of coastal fisheries production, due to reduced donation of materials (food or nutrients) and or energy to surrounding ecosystems.

According to Rifai (2015) that at this time in the Pilang village there has been a conflict of land use between settlements, industry and agriculture. For the use of settlement and industrial land there are about 0.39ha that occur intersection, then between settlements and agriculture about 1.14ha. While the use of land for ponds and agriculture land use conflicts area of 0.74ha. While, the area of mangrove is now beginning to be threatened with the expansion of ponds.

This is because the pond area is currently 52.24ha (14.92% of Pilang 350.13ha). While the mangrove areas currently reach 22,8ha. It is predicted that the area of the pond will penetrate the mangrove area.

In the area of research the presence of mangrove affect pond water quality. This is because Pond Ratio mangrove spelled out a lot. Therefore it is called as mangrove pond. Waters pond environmental conditions indicate the variation between ponds with mangrove. The research area of mangrove pond is called pond forest or silvofishery. This system synergizes maintenance activities, management and efforts of mangrove conservation with cultivation activities combined with mangrove conservation efforts through the activity of arranging the layout of cultivation containers, so that the cultivation activities can be implemented optimally and the preservation of mangrove can be maintained. Thus, according to Fitzgerald (1997) that silvofishery is one cultivation technique that combines the activities of aquaculture with mangrove land management in an integrated manner.

In Kawaroe's research (2001) showed that based on the results of factorial analysis of the correspondent showed that the existence of age group of fish spread in all mangrove ecosystem conditions and a large contribution to the existence of fish in the ecosystem is obtained on the condition of mangrove ecosystem that has a density of 50-200 trees per hectare .

From the results of this analysis can also be seen that the existence of fish with juvenile size spreads on the condition of mangrove ecosystems that have high density (200-300 trees per hectare), litter production 4 tons per hectare per year, and 25-year class. This indicates that these juvenile fish require protected ecosystem conditions in an attempt to avoid predators and poor environments.

Based on the above data, it can be analyzed the decrease of mangrove area in Pilang village caused by several things, namely: (a) pond making and expansion; (b) illegal logging by communities around the mangrove forest; (c) the occurrence of mangrove land conversion is more intensive. While the manufacture and expansion of ponds is due to improve the economy of Probolinggo city in order to encourage local economic growth, as well as beneficial to provide employment. Illegal logging which is one of the causes of the decline of mangrove forest area is caused by the low public awareness and legal rules regarding the unclear utilization, maintenance and preservation of mangrove forest.

In addition, the transfer of mangrove forest land is intensified due to the importance of making various interests for ponds, housing and industry. Thus, the decrease of the mangrove area resulted in the quality of the pond with the silvofishery model decreasing the production of the shrimp.

This is also due to the intensification of coastal abrasion that will make the coastline change and affect the sedimentation in the pond. Another impact that occurs is the decrease in the production of fishery both cultivation and non-cultivation, including the animals around the diminishing. To develop a restoration strategy to increase fishery production, first compiled as shown in table 7 below.

Table 7. List of Powers, Weakness, Opportunity and Threats.

List of Powers	List of Weakness
1. Potential of mangrove to be managed optimally for marine ecotourism; 2. Attention and commitment of local government and provincial government of East Java for conservation of mangrove forest; 3. Strong role of community groups of supervisors	1. The area of mangrove forest is decreasing; 2. Many investors come to the coast to build ponds; 3. There is no restriction on the permit for the construction of ponds; 4. There is no clear regulation on land utilization for ponds; 5. Weak supervision by local government
List of Opportunity	List of Threats
1. Development of the area as a marine ecotourism area; 2. Application of silvofishery system; 3. Determination as a conservation area;	1. Conversion of mangrove land into ponds; Settlement, industry and agriculture; 2. Mangrove is used for everyday purposes: Firewood, building materials; 3. Pilang village residents are increasing

Based on table 7 above then prepared internal strategies and external strategies based on the importance of each SWOT variable. Therefore, in each SWOT variable, the weighting of internal and external strategic factors is assessed. Then, it is organized IFAS (Internal Strategic Factors Analysis) and EFAS (External Strategic Factor Analysis). The next step is to formulate a strategic issue using the EFAS matrix. EFAS matrix is a matrix that describes the composition of a list of external factors that affect the performance of a coastal region. While that includes external factors are opportunities and threats.

While the IFAS matrix is a matrix that describes the composition of a list of internal factors that affect the performance of coastal areas by considering the internal factors of strength and weakness. Rangkuti (2009) explains that strategy is a tool to achieve goals. The main objective is for governments and other stakeholders related to coastal areas to view objectively the internal and external conditions of the region to restore mangrove forest. This is to anticipate changes in the external environment. Table 8 below explains how to strategize by considering the relationship in the SWOT factor.

Table 8. Issues of SWOT Strategy for Mangrove Restoration.

Eksternal / Internal	Opportunity	Threats
	1. Development of the area as a marine ecotourism area (O1) 2. Application of silvofishery system (O2) 3. Determination as conservation area (O3)	1. Conversion of mangrove land into ponds, settlements, industry, agriculture (T1) 2. Mangrove for daily use: Firewood, building materials (T2) 3. Pilang villagers increasing (T3)
Strength 1. The potential of mangrove to be managed optimally for marine ecotourism (S1) 2. Attention and commitment of local government and provincial government of East Java for conservation of mangrove forest (S2) 3. Strong role of community groups of supervisor (S3)	STRATEGY S-O *(using the power to seize the opportunity)* 1. Restoration of mangrove condition with restoration supporting marine ecotourism area, silvofishery 2. Community-based resto ration with full government delegation	STRATEGY S-T *(using the power to overcome the threat)* 1. Tighten licensing for new pond investments; 2. Government commitment to implement community-based restoration programs; 3. Socialization to the community about the existence of mangrove by the community itself through Community groups of supervisor including population control
Weakness 1. The area of mangrove forest began to decrease (W1) 2. The number of investors coming to the coast to build a ponds (W2) 3. There are no restrictions on the construction permit ponds (W3) 4. There is no clear regulation on land use for ponds (W4) 5. Weak supervision by Local Government (W5)	STRATEGY W-O *(overcoming weaknesses to seize opportunities)* 1. Intensification of ponds with silvofishery system 2. Preparation of local regulations on pond land restrictions including the number of investors; 3. Restoration of coastal areas for the development of marine ecotourism areas	STRATEGY W-T *(overcoming weaknesses to seize opportunities)* 1. Intensification of ponds with silvofishery system 2. Preparation of local regulations on pond land restrictions including the number of investors; 3. Restoration of coastal areas for the development of marine ecotourism areas

Based on table 8 above and the first ranking of 10 alternative strategies, it was chosen based on the role of community-based restoration strategy with full delegation from the government. The strategy was chosen as a topic based on SWOT considerations.

For that through the SWOT quadrant formulated mangrove forest restoration strategy in Pilang village by maximizing the potential of existing strength of existing mangrove potential that can grow well in the area.

Besides, the government's commitment, both the provincial government and the city government of Probolinggo, became an important pillar for the restoration of mangrove, including the existence of a community watch group representing the community that must be legally recognized. Strategies to take advantage of opportunities and minimize existing weaknesses and threats form the basis of government programming. In Fig. 3 below shows that the formulation of mangrove forest restoration strategy in Pilang village must be based on unhealthy situation that is conflict of coastal land use by agriculture, industry, settlement and ponds that compete to utilize coastal area. The mangrove restoration strategy should be formulated to reduce the weakness and threat factors as shown in Fig. 3 below.

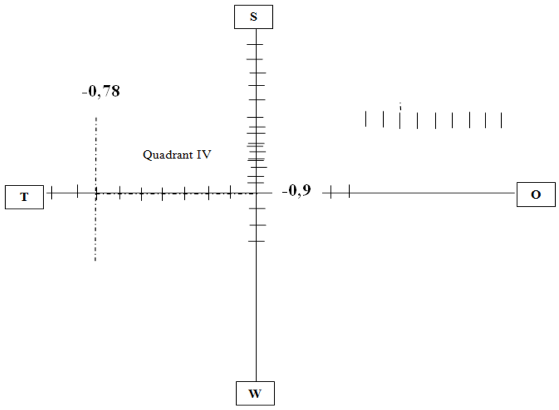


Fig 3. Quadrant Analysis of SWOT.

Based on Fig. 3, the restoration of mangrove forests should be based on the role of the community represented by the community watchdog group actively. However, community watchdog groups should be given full mandate or delegation by the government in the form of financing support for mangrove planting, maintenance of mangrove forest including its preservation, provision of supporting facilities and infrastructure, including giving full delegation from the government on various activities. To face the unhealthy situation due to the weakness and the threat factor, the restoration of mangrove forest to increase the production of fishery in Pilang village, Probolinggo city is suggested as follows:

1. Restoration of mangrove is done based on spatial plan. Therefore, the urban village spatial plan needs to be prepared by making "zoning". For mangrove forests mapping needs to be classified with excellent conditions, good conditions, moderate conditions and critical conditions;
2. Based on the map of the spatial plan, then the program and activities are arranged for 5 (five) years; The programs and activities comprised of three aspects: technical aspect, financing aspect and institutional aspect;
3. For the preparation of the restoration program it is necessary to understand about the autecology of each mangrove species which includes: reproduction pattern, propagule distribution pattern and seedling stabilization. Besides, it is necessary to understand about the hydrologic pattern that affects the distribution, stabilization and growth of mangrove species according to the originals. Besides, for the planting program is done, the number of natural recruitment will not sufficient for healing.
4. Preparation of the spatial regulation and the preparation of restoration programs (both vegetative and nonvegetative programs). This composition refers to the results of research Naamin (1990) which suggests that the presence of mangroves in the area of aquaculture and surrounding areas increase fishpond production.
5. The preparation of the mangrove forest restoration strategy should accommodate environmental, economic and institutional aspects. The target of mangrove cover on mangrove land outside the pond is 50% (sustainable silvofishery target) and mangrove cover in coastal area is estimated at 35% and mangrove land in settlement is 15%.
6. The municipal government provides investors with the right to control ponds including providing optimum input control by producing good traditional pond performance and sustainable capture fisheries performance around the coast.

Conclusion

Coastal restoration is an integrated effort of coastal area management in the form of soft structure and hard structure (wave breaker, wave holder). Therefore, the integration of mangrove ecosystem management includes among others the integration of spatial planning, integration of coastal and coastal development plans, and integration in institutional development across sectors, central and local government relations, and community institutions).

This integration becomes the most important part in the restoration of mangrove forest that aims to increase the production of fishery products. The existence of mangroves in the area of aquaculture and surrounding areas will increase the production of ponds. Thus the restoration of mangrove forest on Pilang coast will: a) maintain the existence of mangrove resources; b) restore the function of damaged mangrove ecosystem; c) protect nature conservation; d). maintaining the sustainable use of resources for human life, especially fish and shrimp in ponds; e). improve the resilience of natural resources to disaster and at the same time maintain the function of protection and recovery from natural disasters. Mangrove restoration efforts become very strategic in securing the production of domestic fisheries both cultivated and non-cultivated. This will support the achievement of national fishery production targets, especially shrimp cultivation of 800,000 tons in 2018. The problem of increasing fishery production is not only on economic aspects such as access to capital for business actors, availability of production facilities and infrastructure, and distribution and marketing. But it also takes into account the environmental aspects that are often forgotten by the government. The main environmental aspects that must be taken into consideration is maintaining the balance condition of coastal ecosystems through the restoration of coastal ecosystems. Especially for research areas that need to be emphasized is restoration of community-based mangrove ecosystem.

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References

Abt Associates. 2014. Estimating The Change in Ecosistem Services Value From Coastal Restoration. Prepared For Center for American Progress and Oxfarm America. Ecosistem Services Values from Coastal Restoration.

Aprianis Y. 2011. Production and Decomposition Rate of Litter Acacia crassicarpa A. Cunn. Di PT. Arara Abadi. Tekno Tanaman Hutan. Vol **4(1),** 41-47.

Blasco F, Aizpuru M, Gers C. 2001. Depletion of the mangroves of Continental Asia. Wetlands Ecology and Management **9,** 245-256, 2001. © 2001 Kluwer Academic Publishers. Printed in the Netherlands.

Boonruang P. 1984. The Rate of Degradation of Mangrove Leaves, Rhizhophoraapiculata BL and Avicennia marina (FORSK) VIERH at Phuket Island,Western Peninsula of Thailand. In Soepadmo, E., A.N. Rao and D.JMacintosh. 1984. Proceedings of The Asian Symposium on Mangrove Environment Research and Management. University of Malaya and UNESCO. Kuala Lumpur. Page 200-208.

Burbridge and Koesoebiono PR. 1980. Management of Mangrove exploitation in Indonesia; Wiroatmodjo, P. and Judi, D.M.1978. Pengelolaan hutan payau di Indonesia / Management of brakish-water forests inIndonesia. Presented at Seminar on Mangrove Ecosystem, 27 February - 1 March 1978, Jakarta.

Cholik F, Poernomo A. 1986. Development of aquaculture in mangrove areas and its relationship to the mangrove ecosystem. In:Mepham, R.H. 1986. Papers contributed to the workshop on strategies for the management of fisheries and aquaculture in mangrove ecosystems. Bangkok, Thailand 23 June 1986. p. 93-104.

Chongs. 2007. Mangroves-Fisheries Linkages-The Malaysian Perspective. Bulletin of Marine Science **80(3),** 755-772, 2007

Dahuri R. 2003. Marine Biodiversity: Indonesia's Sustainable Development Asset. PT Gramedia. Jakarta. xxxiii + 412 p.

Darsidi A. 1984. Mangrove forest management in Indonesia. In:Soemodihardjo, S. *et al.* (eds) Proceedings of the Seminar on the mangrove ecosystem II, Baturaden, 1982. LIPI: 19-26.

Dharmawan IW, Zammani E, dan NP, Maduppa HH. 2016. Leaf Decomposition Rate at Kelong Island Mangrove Ecosystem, Bintan Regency. Journal of Oceanography and Limnology **1(1),** 1-10.

Department of Marine and Fishery of Probolinggo City. 2014. Mangrove Mapping Survey. Probolinggo: Department of Marine and Fisheries. Department of Marine and Fisheries.

Duke NC, Meynecke JO, Dittmann S, Ellison AM, Anger K, Berger U, Cannicci S, Diele K, Ewel KC, Field CD, Koedam N, Lee SY, Marchand C, Nordhaus I, Dahdouh-Guebas F. 2007. A world without mangroves? Science **317(5834),** 41-42.

FAO. 1982. Management and utilization of mangroves in Asia and the Pacific. FAO environment paper **3,** 160 pp.

FAO. 2003. Status and Trends in Mangrove Area Extent World Wide. Forest Resources Division, FAO, Paris.

FAO. 2007. The world's mangrove 1980-2005. FAO forestry paper 153, Rome, Italy.

FAO, 2008. Loss of mangroves alarming. Rome: Food and Agriculture Organisation of the United Nations. Online at: www.fao.org/newsroom/ en/news/2008/1000776/index. html.

Fiztgerald WJ. 1997. Silvofisheries: An Integrated Mangrove Forest and Aquaculture System. http://www.agri-aqua.ait.ac.th/mangroves.

Gilman E, Ellison J, Duke NC, Field C. 2008.Threats to mangroves from climate change and adaptation options: a review. Aquatic Botany **89(2),** 237-250.

Giesen W. 1993. Indonesia's mangroves: an update on remaining area and main management issues. Presented at the international seminar on coastal zone management of small island ecosystems. Ambon 7 - 10 April 1993. AWB Indonesia. 10 pp.

Hartini S, Saputro GB, Suprajaka MY, 2010. Assessing the use of remote sensed data for mappingmangrove Indonesia. Selected Topics in Power System and Remote Sensing. In 6th WSEAS International Converence on Remote Sensing (REMOTE 10). Iwate Prefectural University, Japan, October **4-6, 2010,** 210-215.

IPCC. 2007. Summary for policymakers. Climate Change 2007:impacts, adaptation and vulnerability. Contribution of WorkingGroup II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (ed. by M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden & C.E. Hanson), pp.7-22. Cambridge University Press, Cambridge. Switzerland.

IUCN. 2006. Conservation Benefits of Mangrove. The World Conservation Union. IUCN Policy Brief.

IUCN. 2010. Mangrove forests in worldwide decline. downloaded in www.iucn.org/content/ mangrove-forests-worldwide-decline on 2 January 2018

Yuliana, Darma, Johannes Hutabarat, Rudhi Pribadi, Jusup Suprijanto. 2013. Conservation of mangroves as a potential supporter of coastal fishery in Pemalang. Annual National Seminar X . The results of Marine and Fisheries research 31 August 2013.

Kathiresan K, dan, Bingham BL. 2001. Biology of Mangrove and Mangrove Ecosystems. Centre of advanced Study in Marine Biology, Annamalai University. Huxley College of Environmental Studies, Western Washington University. Annamalai, India.

Kawaroe, Mujizat. 2001. Contribution of Mangrove Ecosystem to Fish Community Structure in North Coast Subang Regency, West Java. Coastal Journal and oceans Vol **3(3),** 2001 ISSN 1410-7821.

Kitamura S, Anwar C, Chaniago A, Baba S. 1997. Handbook of mangroves in Indonesia - Bali & Lombok - JICA, ISME, Japan p.119.

MA (Millenium Ecosystem Assessment). 2005. Mille Ecosystems and Human Well-Being Synthesis. Island Press, Washington DC.

Melana DM, Atchue J, III Yao CE, Edwards R, Melana EE, Gonzales HI. 2000. Mangrove Management Handbook. Coastal Resource Management Project of The Department of Environment and Natural Resources. Supported by United States Agency for International Development. Printed in Manila. Published in cooperation with the Fisheries Resource Management Project, which is implemented by the Department of Agriculture-Bureau of Fisheries and Aquatic Resources, and funded by the Asian Development Bank and Japan Bank for International Cooperation.

Naamin N. 1990. The Use of Mangrove Forest For Pond Culture: Profits and Disadvantages. The Use of Mangrove Forest For Pond Culture: Profits and Disadvantages. MAB Indonesia-LII Bandar Lampung.

Onrizal & Kusmana C. 2008. Mangrove Forest Ecology Study on the East Coast of North Sumatra. Biodiversity **9(1),** 25-29.

Pemerintah Kota Probolinggo. Probolinggo City Environmental Management Performance Information Document 2016. Probolinggo City of Government. 2016.

Pemerintah Kota Probolinggo. 2016. Probolinggo Mayor's Accountability Report to the Probolinggo Regional People's Legislative Assembly of 2015. Probolinggo City of Government. 2016.

Prahastianto, Edi Fajar. 2010. The existence of Mangrove and fish production in Grinting Village, Bulakamba District, Brebes Regency. Department of Water Resources Management, Faculty of Fisheries and Marine Sciences, Bogor Agricultural University.

Ramaniya, Dian. 2017. Relation of Mangrove Forest Density to Bivalvia Density for Determination of Conservation Area in Pilang Village, Kademangan Sub-district, Probolinggo City, East Java. Essay. Marine Studies Program. Universitas Brawijaya, Malang.

Ramli, Muhammad. 2012. Contribution of Mangrove Ecosystems as a Supplier of Fish Feeding (Liza subviridis) In North Coast of Konawe Selatan South East Sulawesi. Dissertation. Graduate School. Bogor Agricultural Institute.

Rangkuti, Freddy. 1997. SWOT Analysis Techniques Dissecting Business Cases. Jakarta: Gramedia Pustaka Utama.

Rani, Chair. Production Model of Mangroves Leaf Litter Rhizophora apiculata, Blume and Its Contribution to Seagrass Fishing and Coral Reefs. http://repository.unhas.ac.id/bitstream/ 12345 789/93/model%20serasah-protein1.pdf? sequence=1 diunduh tanggal 28 September 2017.

Rani, Refilian Al. 2017. Composition and Structure of Mangrove Stands and Carbon Potential Stored On Vegetation of Mangrove and Sediment in Coastal Area of Pilang Village, Probolinggo Municipality. Essay. Marine Science Study Program, Department of Fishery and Marine Resources Utilization. Universitas Brawijaya, Malang.

Richards DR, Friess DA. 2016. Rates and drivers of mangrove deforestation in Southeast Asia, 2000–2012. Proceedings of the National Academy of Sciences of the United States of America. 2016; **113(2),** 344-349. doi:10.1073/pnas.1510272113.

Rifai, Noor. 2015. Mapping of Coastal Resources Potency of Pilang Village, Kademangan Sub-district, Probolinggo Municipality, East Java. Essay. Faculty of Fisheries and Marine Sciences, Universitas Brawijaya.

Roberston A, Duke NC.1987. Mangrove as a Nursery Sites: Comparisons of the Abundance and Species Composition of Fish and Crustaceans in Mangroves and Other near Shore Habitats in Tropical Australia. Marine Biology, Vol. **96(2),** 1987 pp. 193-206. http://dx.doi.org/10.1007 /BF00427019

Snedaker SC. 1984. The Mangroves of Asia and Oceania: Status and Research Planning. In: proceedings of the Asian Symposium on Mangrove Environment Research and Management, p 5-15 Kuala Lumpur, August 25-29, 1980. Edited by E. Soepadmo, A.N. Rao and D.J. MacIntosh. 1984

Soemodihardjo S, Wiroatmodjo P, Abdullah A, Tantra IGM, Soegiarto A. 1993. Condition, socioeconomic values and environmental significance of mangrove areas. In: Clough, B.F. 1993. The Economic and environmental values of mangrove forests and their present state of conservation in the South-East Asia/Pacific Region. p. 17-38 Mangrove Ecosystems Technical Reports vol.**3** ITTO/ISME/JIAM Project PD71/89. Rev. 1 (F) Okinawa, Japan, ISME. 202 pp.

Spalding MD, Blasco F, Field CD. 1997. World Mangrove Atlas. International Society for Mangrove Ecosystems. Okinawa, Japan.

Sundari. 2017. Mangrove Forest Damaged by Banjir.html. Taken June **10,** 2017, from www.wartabromo.com.

Thayer GW, Colby DR, Hettler Jr WF. 1987. Utilization of the Red Mangrove Prop Root Habitat by Fishes in South Florida, Marine Ecological Progress Series, Vol. **35,** 1987, pp. 25-38. http://dx.doi.org/ 10.3354/meps035025

Wiyono, Mardi. 2009. Mangrove Forest Management and its attraction as a tourist attraction in the city of probolinggo. Journal of Application Management Volume **7(2).** May 2009.

Zamroni Y, dan Rohyani IS. 2007. Production of mangrove forest litter in coastal waters of Dusun Selindung, West Lombok. National Seminar on the Development of Mathematics and Mathematics and Natural Sciences (MIPA) Towards Professionalism of Teachers and Lecturers. University of Mataram, Mataram, November **3,** 2007.