Mangrove management collaboration in the Marusu coastal region of Maros regency

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Abstract Coastal area is a gateway for various human development activities. In other words, the coastal region is the first time and received the most pressure compared to other regions. The aim of this study is to identify mangrove damage and its causes to formulate collaborative management that is more directed towards sustainable management while taking into aspects of the function and role of mangroves as a tool for natural coastal protection and security. The research conducted from April to November 2019 in the coastal area of Marusu, Maros Regency, South Sulawesi Province. Data collection is done through map analysis, survey and in-depth interviews. Mangrove ecosystem analysis, satellite imagery data and SWOT analysis are used to achieve the research objectives. The area of mangrove forests in 2009, 2014, 2016 and 2019 was 105.85 Ha, 101.07 Ha, 92.06 Ha and 100.06 Ha, respectively. Changes in land cover since 2009 towards the end of 2014, the conversion of mangrove forests into ponds and dry land agriculture from 2009 to 2014 covered 5.83 (5.51%) and 6.82 Ha (6.64%). Damage to mangrove forests contributes to abrasion, intrusion of sea water, and loss of habitat for animals such as birds, mammals, reptiles, insects, and various marine biota. SWOT analysis a sustainable management strategy in the form of SO. Zoning of mangrove ecosystems, into the core zone and cultivation zone. ST, Policies and regulations that are appropriate and binding. WO, Knowledge upgrading regarding the benefits of the existence of mangrove forests. WT, management of mangrove forests based on pentahelix partnerships.

1. Introduction

Coastal areas are part of the transition between land and sea. The biotic and abiotic wealth in this region depends on the use made by humans. One characteristic of the coastal area is the presence of mangrove ecosystems is the first layer of land to prevent abrasion. Coastal is a gateway for various human development activities as well as being the region that receives the most pressure. Trade and development activities cause coastal areas to be vulnerable to changes both naturally and physically resulting in a decrease in environmental quality. One of them is the mangrove ecosystem. Understanding the mangrove ecosystem in general is a tropical coastal vegetation community that is dominated by several species of mangrove trees that grow and develop in muddy tidal areas [1]. When compared with other forest ecosystems, the mangrove ecosystem has specific flora and fauna and has a high diversity.

Maros Regency as a coastal and marine area has the potential to develop land and sea fisheries which is quite large. Marusu Subdistrict has the largest mangrove in Maros Regency which is 101.07 ha along the coast and around river mouths. Nisombalia Village is one of the coastal villages in Marusu District, which is approximately 30 km from Makassar City to the north. The total area of the village is 1333.62 Ha. Based on the results of the Agricultural Census of the Central Statistics Agency (BPS) in Maros 2013 there were 144 households conducting aquaculture / brackish fish farming and 242 households with capture fisheries at sea in Nisombalia Village. The average population in the village of Nisombalia depends on marine products, so it is certain that the function of mangroves in this village is very important in terms of its ecosystem and economy.

Maros Regency itself actually has a regional regulation on mangrove conservation which was passed in 2015 in the form of Regional Regulation number 03 of 2015 concerning conservation, management and utilization of mangroves, violations still occurred by the community and even the government itself [2]. Ironically, the coastal residents who feel they own/claimed as the owner of this region are increasingly powerless to compete with other parties. Resource utilization activities by ignoring the rules of sustainability must be in order to meet the needs of daily life. To anticipate conflicts and negative impacts, appropriate management collaboration is need through the application of the principles of management and utilization of natural resources that are ecologically sound and continue to receive economic benefits in a sustainable manner.

The purpose of this study is to identify mangrove damage and its causes so that sustainable management collaboration can be formulated that still consider aspects of the function and role of mangroves as a means of natural beach protection and security.

2. Material and Method

This research conducted in the coastal area of Marusu, Maros Regency, South Sulawesi Province, from April to November 2019.
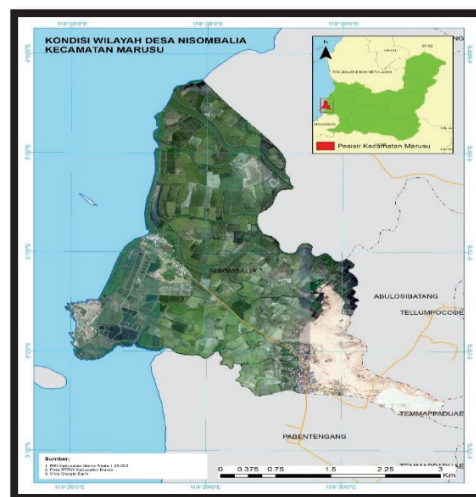

Figure 1. Map of the Study Plan Location (Desa Nisombalia).

2.1. Materials and Tools

Table 1. Research materials

No	Material	Quantity	Utility
1	landsat ETM 7+ and Landsat 8 OLI	4 Packages	Analysis of land cover
2	Articles related to research		Research supporting data, depending study previous
3	RBI Map	1 package	Topography data of research location
4	Map land cover	4 Packages	Analysis of changes in mangrove area

Table 2. Research tools

No	Material	Quantity	Utility
1	GIS software	1 Unit	Analysis landsat imagery and land cover change
2	GPS	1 Unit	To knowing the coordinates of observation point
3	Computer	1 Unit	To processing data
4	Stationary	1 Set	To writing data in the field

2.2. Population and Sample

Primary data can be obtained from direct surveys in the field and / or from GIS data (Geographic Information System) and sensory technology (remote sensing, i.e. Landsat 8 OLI satellite imagery). The population of this research is the mangrove forest located in the Nisombalia Village, Maros District. The research sample in the form of points determined randomly from the results of Landsat Satellite imagery data processing.

2.3. Data Analysis

After the data is obtained either primary or secondary, then the data is processed using several data analysis techniques. The analysis that must be done in this study is as follows.

2.3.1. Mangrove Ecosystem Analysis. To determine the biophysical environmental factors that influence the mangrove forest damage, it is necessary to collect primary and secondary data. This can be through surveys with qualitative descriptive methods. The parameters that need to be observed in the survey include: area data, type of land cover and land use, community livelihood composition related to the use of mangrove forests. To deepen the study, it is also necessary to look at secondary data and relevant previous research results.

Criteria for determining the critical level of mangrove land using GIS technology and remote sensing:

a. Types of land use that can be classified into three categories, namely: 1) forests (forested areas), 2) intercropping and plantation ponds and 3) non-vegetation forest areas (settlements, industry, non-intercropping ponds, rice fields and vacant land).

b. Canopy density, which based on the value of NDVI (Normalized Difference Vegetation Index) classified into: heavy, moderate and rare canopy density

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c. Soil resistance to abrasion can be obtained from land system maps or land use systems as seen from land use and other GIS data. In this case, soil type divided into three categories, namely: Unsensitive, sensitive and very sensitive of erosion

2.3.2. Satellite Imagery Data. Landsat satellite imagery have to be corrected radiometrically and geometrically to eliminate errors in recording satellite image data caused by the distance / height of the satellite, atmosphere, and satellite motion and earth's rotation. The target location for this activity is mainly the coastal area in Maros Regency. Based on the coverage index of satellite imagery of Landsat 7+ ETM and Landsat 8 OLI, several scenes where located in the coastal area. The first stage was assessed using GIS (Geographic Information System) technology and remote sensing (satellite imagery) of the mangrove area to be inventoried, then the field checking stage was carried out on the results of the interpretation and analysis of satellite images. In this stage, the activities of procuring landsat image data are carried out and making maps of the results of image processing and secondary data results, namely land cover / land use maps and types of mangroves and mangrove density maps.

2.3.3. SWOT Analysis / Collaborative Formulation. Determining collaborative management of mangrove forest ecosystems in Maros Regency currently using SWOT analysis. General SWOT is an abbreviation of the internal environment Strengths and weaknesses and the external environment opportunities and threats. SWOT analysis compares the external factors of opportunity (O) and threats (T) with the internal factors of strengths (S) and weaknesses (W).

The purpose of this analysis is to determine strategic factors both internal and external that will determine the future including:

• internal (performance): organizational structure, culture, resources (assets, skills / HR, knowledge, etc.)
• external: politics, social, economic, and technology

3. Result and Discussions

3.1. Nisombalia Village Condition

Based on the Marusu Subdistrict statistics in 2016 the Nisombalia Village is located in the coastal area of Marusu Subdistrict, the village with the largest area at an altitude of 0-30 meters above sea level. The distance from the sub-district capital is five kilometers and 12 kilometers from the district capital. The village consists of four hamlets, namely Mambue, Tala-Tala, Kuri Lompo and Kuri Caddi. The total area of the village is approximately 1333.62 Ha. Nisombalia Village residents mostly work in the maritime sector (fishermen), farming, fishponds and livestock businesses. A small portion become traders or entrepreneurs and become civil servants and the rest are unemployed [3].

3.2. Land Cover Change of Mangrove forest

Boundaries based on the Indonesian Rupa Earth Map (RBI) scale of 1: 25,000, area of Nisombalias Village is 1333.62 Ha. Consists of 40.14 Ha of water bodies, 50.59 Ha of forests, 105.59 Ha of mangrove forests, Settlement of 20.45 Ha, 131.41 Ha of dry land agriculture, 54.27 Ha of paddy fields, 929.82 Ha of ponds, and land open 1.07 Ha. Changes in land cover since 2009 towards the end of 2014, the conversion of mangrove forests into ponds 5.83 (5.51%) Ha and dry land agriculture 6.82 Ha (6.64%). The condition of the aquatic environment affects all forms of life in it, the most extensive land cover ponds in Nisombali

village which cover 67.73 % per total area, in the Kuri Caddi Hamlet converted to mangrove-covered land as a pond association to improve water quality.
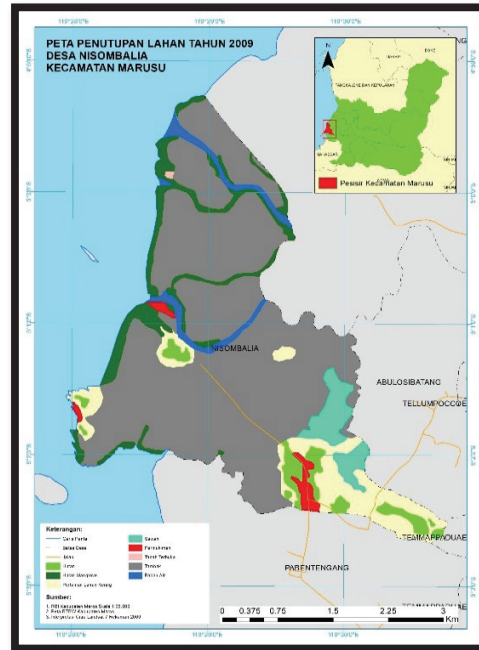

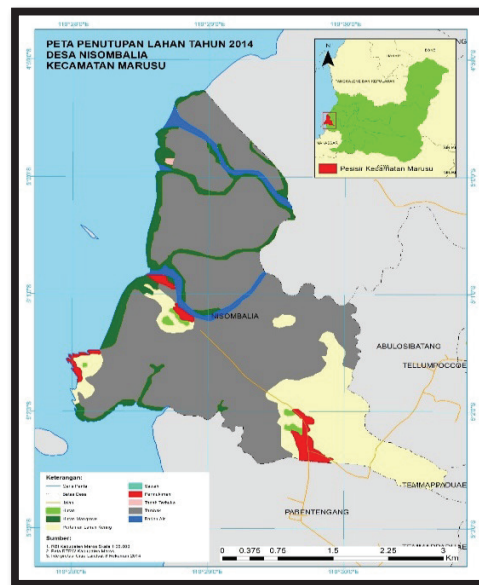**Figure 2.** The Map of Nisombalia Vlillage Land Cover 2009

Figure 3. The Map of Nisombalia Vlillage Land Cover 2014

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Conversion of mangrove areas is closely related to high population and low economic levels. As the coastal population of Nisombalia Village has increased in the last few years, followed by the rapid development of supporting facilities and infrastructure, the need for shelter has also increased. Likewise with the needs of agricultural land and ponds, which caused the end of 2016 mangrove forests decreased by 20.46%.

The socioeconomic benefits of the mangrove ecosystem for the coastal communities of Nisombalia Village, as a source of livelihood. The results of Dahuri (2004) research identified approximately 70 kinds of uses of mangrove trees for human interests, both directly and indirectly. Excessive use of mangrove forest and the absence of sustainable planning causes 26.33 Ha of open land without conservation or other uses.

Table 3. Land cover changes at Nisombalia Village in 2009-2019

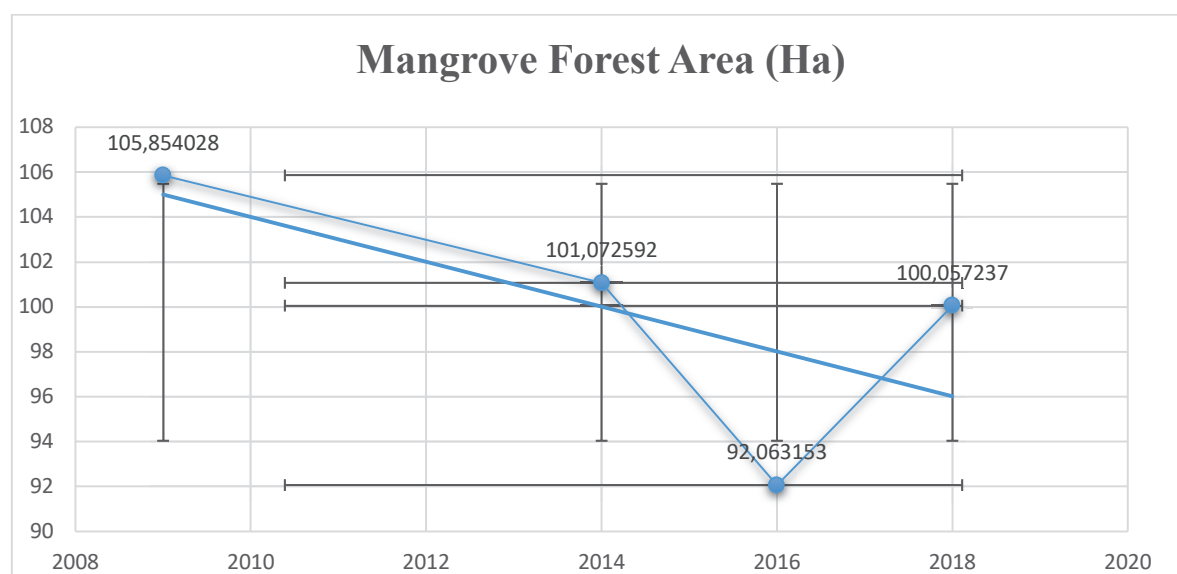| No	land cover	land cover area (Ha)			
		2009	2014	2016	2019
1	forest	50.59	07.71	3.60	-
2	Mangrove forest	105.85	101.07	92.06	100.06
3	Dry land agriculture	131.41	241.86	228.05	206.38
4	Paddy field	54.27	-	-	-
5	Fishpond	929.82	910.60	909.97	903.27
6	Settlement	20.45	31.16	33.46	37.77
7	Open land	01.07	01.07	26.33	44.02
8	Water bodies	40.14	40.14	40.14	40.14

Figure 4. Diagram of mangrove forest cover 2009-2019

The total area of mangrove forests in 2009, 2014, 2016 and 2019 were 105.85 Ha, 101.07 Ha, 92.06 Ha and 100.06 Ha, respectively. In Table one the massive conversion of mangrove forests carried out by

coastal communities until 2016 reached 13.79 Ha. The impact of the reduced mangrove forest area began to be felt by the coastal communities of Nisombalia Village, then in 2017 conservation carried out. A number of plantations were carried out in several vulnerable points, especially on coastal abrasion, the results obtained until the end of 2019, the area of mangrove forests has increased by 8.01 Ha (8.70%).
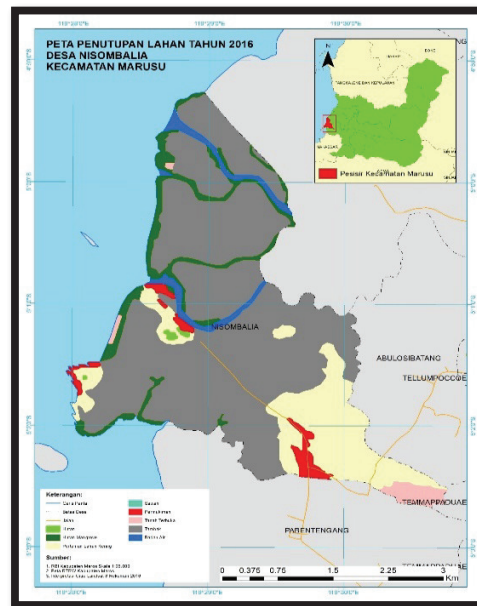

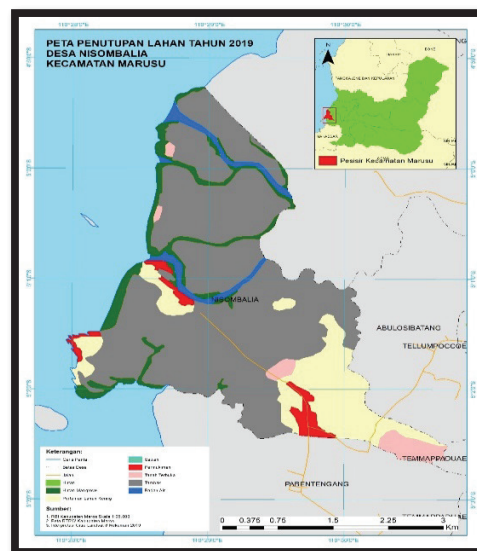**Figure 5.** The Map of Nisombalia Vlillage Land Cover 2016

Figure 6. The Map of Nisombalia Vlillage Land Cover 2019

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3.3. Impact / Influence of Environmental Balance Mangrove Forest Degradation in Nisombalia Village

Mangrove forest ecosystem is a natural and renewable resource, so that efforts are made to correlate and or be able to support development (economy) without compromising its ecological value by maintaining the integrity of functions and its sustainability. Mangrove forest ecosystems are very important in the management of coastal resources, especially small islands. Mangroves act as filters to reduce adverse effects and major environmental changes and as a food source for marine (coastal) and new biota. In addition, this ecosystem also functions in treating waste through absorption of excess nitrate and phosphate so as to prevent pollution and contamination in the surrounding waters.

Nisombalia Village is the location of this research, is administratively included in the demographic of Marusu District, Maros Regency. The village consists of four (4) hamlets namely Mambue, Tala-Tala, Kuri Lompo and Kuri Caddi. The total area of the village is approximately 1333.62 Ha. The majority of Nisombalias villagers work in the maritime sector (fishermen), farming, fishponds and animal husbandry. A small portion become traders or entrepreneurs and become civil servants and the rest are unemployed [3]. Nisombalia Village is one of the coastal areas rich in marine resources. Utilization of the potential of existing marine resources is carried out jointly in increasing income which then forms a work structure, even though the employment relationship that exists is only limited to ordinary work relations.

The work structure that is not well managed as well as its relationship to the needs of clothing, shelter, and food that continues to increase along with the increase of population in the village of Nisombalia. It caused the mangrove forests that should be used as a protected zone in the coastal area on a massive conversion both residential land and pond land. From 2009 to 2016 the area of mangrove forest that was converted was 13.79 Ha. This change clearly had a negative impact / influence on the balance of the coastal ecosystem of Nisombalia Village.

3.3.1. Coastal Area Abrasion Due to Conversion of Mangrove Forests

Decreased area of mangrove forests caused by community land conversion directly impacts coastal ecosystems. The greater damage mangrove forests contribute to abrasion in coastal areas, especially when the mean sea level (MSL) is relatively high. A large enough wave will also transport the substrate which is a food storage in the mangrove forest. Loss of substrate means loss of place of life for a number of inhabitants of the ecosystem. This results in decreased species richness and density.

Marusu in numbers, especially in the village of Nisombalia based on census data from the Central Statistics Agency there are 4001 people. Social life depends on the availability of facilities and infrastructure as well as public facilities. People in Nisombalia Village are often hampered by their activities due to the inundation of a number of public facilities, settlements and so on. The main trigger for this incident is due to abrasion as a result of reduced mangrove forest leaks. The impact of coastal abrasion is felt during sea tides, hundreds of hectares of ponds sink. This causes huge losses for coastal communities.

3.3.2. Loss of Animal Habitat Due to Conversion of Mangrove Forest.
Biologically mangrove vegetation serves as a natural habitat for various species of birds, mammals, reptiles, and breed insects (nursery ground), various marine biota such as shrimp, fish, and crabs, also make mangrove forests as a place for spawning (spawning ground) and looking for food (feeding ground). The conversion of mangrove forests has an impact on the loss of habitat for number of economically valuable commodities such as fish, shrimp and crabs. Salim et al., (2016) revealed that the loss of one ha of mangrove led to a loss of shrimp /

fish production by 480 kg / year. Interviews with the community revealed a decline in the catch of shrimp, fish and crabs [4].

3.3.3.Mangrove Sea Water Intrusion Due to Conversion of Mangrove Forests. The research of Salim et al. (2016) in three villages showed that in the two villages of Subang Regency the shoreline closure of the pond had a rather brackish water quality category due to sea water intrusion. Whereas villages with pond closures associated with mangroves have fresh water quality [4]. Facts on the ground show that saltwater intrusion in Banten Bay due to the conversion of mangrove forests covering an area of 511 ha has an impact on sea water intrusion along four kilometers of coastline, with the possibility that this could also occur in Nisombalia Village if mangrove forest conversion occur continuously.

3.3.4. Mangrove Forest Conservation. The coastal topography of Nisombalia Village is a determining factor in the characteristics of mangrove structures, in particular the species composition, species distribution and size of mangrove forests. The high tide of sea water is determined on the beach slope equivalent. The impact of mangrove forest damage that occurred on coastal communities has encouraged the planting of mangroves since 2017. Increased area and accretion of mangrove forests is answer from the correlation between facts on the ground and the results of the analysis of visual interpretation of Landsat 8 imagery in 2019.

Increasing mangrove forest area also provides a home for occupant species. Various research results proved that the greater the area of mangrove forests will increase the production of fish and other mangrove commodities. The density of mangrove forests also positively influences the production of economically valuable species such as mangrove crabs. Tanakeke Island, Takalar Regency has a huge benefit value from mangrove forests, the results of Anhar et al. (2019) said that the existence of mangrove rehabilitation activities over the past 5 years contributed well [5].

Some studies suggest that mangrove forests with certain stand criteria have the potential to reduce waves by up to 50%. Research conducted in Grajagan Bay, Banyuwangi showed results that waves as high as 1.09 m with a strength of 1431.33 Joules were able to be reduced by mangrove forests to 0.73 m. The existence of mangrove forests has a big influence on people from various sectors. Sustainable management is the key to getting the benefits above. Although the benefits of mangrove planting yet have no significant impact on the economic and social Nisombalia coastal communities. The fact is the high frequency of flooding during high tides.

3.4. Potential and Constraints Analysis (SWOT)
The purpose of this SWOT analysis is to determine the strategies of internal and external factors that have been identified. Internal factors or IFAS (Internal Strategic Factor Analysis Summary) are factors that originate from the mangrove. SWOT analysis is the systematic identification of various factors to formulate a strategy, which is based on logic by maximizing strengths and opportunities while simultaneously minimizing weaknesses and threats.

Table 4. Internal Factor Weighting and Rating

Factors Internal	Weighting	Rating	Value
STRENGTH = S			
Mangrove ecosystems as biological wave dampers (vegetative)	4	4	16
Mangrove ecosystems as a natural filter for sea water intrusion	4	4	16
Mangrove ecosystems act as nursery ground and spawning ground	4	4	16
Potential increase in regional GRDP	4	3	12
TOTAL			*60*
WEAKNESS = W			
Conversion of mangrove forests to other land use	5	4	20
Institutions and management of mangrove forests that have not been running well	4	4	16
Low quality of human resources for sustainable management of mangrove forests	4	3	12
TOTAL			*48*

Table 5. External Factor Weighting and Rating

Factors external	Weighting	Rating	Value
OPPORTUNITY = O			
Mangrove ecosystems can become the center of tourism with the concept of eco-edu-tourism	5	4	20
Mangrove ecosystems can encourage social welfare	4	4	16
Mangrove ecosystems can drive an increase in coastal communities	4	4	16
TOTAL			*52*
THREATHS = T			
Lack of community conservation awareness coastal management of mangrove forests	5	4	20
Inadequate road accessibility	3	3	9
There is no binding policy on mangrove forest conservation	4	3	12
TOTAL			*41*

Table 6. Alternative Ranking Strategy

Element of swot	Contiguity	Total score	Rangking
STRATEGI SO	S (1-2), O(1-2)	112	1
STRATEGI ST	S (1-2), T(1-2)	101	2
STRATEGI WO	W(1-2), O(1-2)	100	3
STRATEGI WT	W(1-2), T(1-2)	89	4

Results of SWOT analysis, collaboration of mangrove management obtained in the form of:
SO, zonation of mangrove ecosystems, into the core zone with protection function and cultivation zone as a function of utilization, in an effort to improve and or maintain the presence of mangrove forests.

ST, Appropriate and binding policies / regulations, associated with funding accompanied by periodic coaching clinics in the effort to manage mangrove forests in a sustainable way.

WO, Knowledge upgrading regarding the benefits of the existence of mangrove forests, accompanied by the provision of ideal institutional management, to achieve socio-economic welfare of coastal communities, and sustainable.

WT, partnership-based mangrove forest management which involves five elements (pentahelix) i.e community (community), academics, government, business and media.

4. Conclusion

The total area of mangrove forests in 2009, 2014, 2016 and 2019 were 105.85 Ha, 101.07 Ha, 92.06 Ha and 100.06 Ha, respectively. Changes in land cover since 2009 towards the end of 2014, the conversion of mangrove forests into ponds and dry land agriculture from 2009 to 2014 covered an area of 5.83 (5.51%) and 6.82 Ha (6.64%). The results of image interpretation show that the area of mangrove forests in 2019 will increase by 8.01 Ha. Damage to mangrove forests contributes to abrasion, intrusion of sea water, and loss of habitat for animals such as birds, mammals, reptiles, insects, and various marine biota.

SWOT analysis conducted provides several management collaboration options in the form of SO, zonation of mangrove ecosystems, into the core zone with protection functions and cultivation zones as functions of utilization. ST, Appropriate and binding policies / regulations, associated with funding accompanied by periodic coaching clinics in the effort to manage and manage mangrove forests in a sustainable and sustainable way. WO, Knowledge upgrading regarding the benefits of the existence of mangrove forests, accompanied by the provision of ideal institutional management, to achieve socio-economic welfare of coastal communities, sustainable and sustainable. WT, partnership-based mangrove forest management which involves five elements (pentahelix) namely community (community), academics, government, business and media.

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