

# Activity Recommendations Based on an Environmental Approach in Zoning of Marine Protected Areas (MAPS) Pariaman City - Indonesia

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## Abstract

The research purpose is to recommend zoning for Marine Protected Areas (MAPs) as marine protection and aquatic business license based on Sustainable Development Goals (SDGs) to the government in Pariaman City, West Sumatra Province, Indonesia. The method used is descriptive with the characteristics of the population or phenomenon being studied and the formulation of results of zoning with an environmental approach. The analysis results for recommendations of the zoning for MAPs in Pariaman City the area of 11,776 ha is divided into 3 zones, namely the core zone with an area of 249.31 ha (2.2%); the sustainable fishery zone with an area of 11,459 ha (97.3%); and the utilization zone with an area of 67 ha (0.6%). Activities that can be carried out in 1) core zone to conserve and restore the region so that the biota in this zone can breed properly; 2) sustainable fishery zone to support the preservation of aquatic resources and their habitats; and 3) utilization zone for tourism, research, ecosystem rehabilitation, and natural restocking. The MAPs is an important document for the government of Pariaman City according to the regulation of the Ministry of Marine Affairs and Fisheries (PERMEN KP), the Republic of Indonesia; No. 30/2010, concerning "Management of Coastal and Small Islands" for the Republic of Indonesia.

**Keywords:** Marine Protected Areas; Coastal; Small Islands; SDGs; Pariaman

## 1. Introduction

The space utilization of coastal and small islands is an effort to realize sustainable natural resource management. These space utilization efforts are closely related to the characteristics of coastal and small islands as common property resources and fluids that are constantly moving (Cicin, 1993; Levine *et al.*, 2015; Ullah *et al.*, 2021). Grip & Blomqvist (2020); Hribar *et al.* (2023) defines common property resources everyone can use, these resources are freely available to anyone who wants to use them. Examples are water, irrigation systems, fish in the sea, grasslands, fish stocks, forests, and the atmosphere. While the fluid properties are closely related to the nature of marine waters where the movement of the ecosystem cannot be

limited and is a source of conflicts of interest in various sectors in its utilization. The utilization resources of coastal and small islands if not managed sustainability will one-day experience degradation. For this reason, management efforts are needed by the principles of sustainability.

The zoning for MAPs is used as the basis for effective management, namely allocating part of the region of coastal and small islands as a place of protection for economically important marine biotas including conservation of endemics, that are threatened with extinction, among them are *Batoidea/Manta rays*, *Rhincodon typus*, *Napoleon wrasse*, *Tenualosa*, *Pterapogonkauderni*, Turtles (*Lepidochelys olivacea*, *Chelonia mydas*, *Eretmochelys imbricata*), *Trochus niloticus*,

*Hippocampus comes*, *Hippopus porcellanus*, *Ornamental coral*, and *Sea bamboo*. Then it was stated in Jefferson *et al.* (2021) that there was 11 priority endangered marine species included in the program of National Action Plan (RAN) 2015-2019. The marine species are *Holothuroidea*, *Hippocampus comes*, *Carcharhinus longman*, *Clams*, *Anguilla japonica*, *Napoleon wrasse*, *Cetaceans*, *Sea Bamboo*, *Turtles*, *Batoidea/Manta rays*, and *Trochus niloticus* (Ghandour & Haredy, 2019; Mateos-Molina *et al.*, 2020; Dewata & Putra, 2021). The zoning for MAPs is an allocation of water space based on the region's function, environmental suitability, and regional carrying capacities (Wei *et al.*, 2014).

In research Mu *et al.* (2013); Kusumawati & Huang (2015); Habtemariam & Fang (2016); Suasti *et al.* (2020) explain that MAPs function to protect marine biotas and regulate sustainable utilization of fishery resources, where the regulation of MAPs through a zoning system with the division of core, utilization, and sustainable fisheries. Based on research by Krueck *et al.* (2017), the core zone area in MAPs is a minimum of 20 - 30 % to maintain the sustainability of the biotas stock that is the target of utilization. Rodwell *et al.* (2003); Harmelin-Vivien *et al.* (2008); Pérez-Ruzafa *et al.* (2017); Giakoumi & Pey (2017); Cheng *et al.* (2019) add the MAPs created to manage and conserve fish resources. Where the core zone is prohibited from fishing to maintain fish stocks, the core zone also improves habitat quality, restores ecosystem function, and increased the population-biomass of fishery products in adjacent regions.

Pariaman City is one of the coastal cities in the Western part of Sumatra island, which has an area of 7,336 ha (with 4 small islands, namely: *Angso Duo*, *Tengah*, *Ujuang*, and *Kasiak*) from 28,256 ha a sea region with a coastline of 12 km, the mangrove ecosystem area is 18 ha, and the coral reef area is 261.72 ha (Oktorie *et al.*, 2019). Based on the Decree of the Governor of West Sumatra Province No. 523.6/150-2017 concerning "Reservation of Regional Conservation", the MAPs in Pariaman City is 11,775.63 ha. According to Hermon *et al.* (2020); Sriaivrina & Frinaldi (2022),

the current utilization space in the MAPs in Pariaman City is for capturing fisheries, marine tourism, shipping lanes, coral reef conservation, and turtles.

In managing coastal and small islands, it is necessary to review and evaluate the document from the zoning for MAPs, because there was an error in the assessment which was allocated to the currently existing conditions in Pariaman City, as stated in 1) Regional Regulation (PERDA) West Sumatra Province No. 2/2018 concerning "Zoning Plan for Coastal and Small Islands (RZWP-3-K) West Sumatra Province for 2018-2038"; 2) PERDA Pariaman City No. 21/2012 concerning "Regional Spatial Planning (RTRW) Pariaman City 2010-2030"; and 3) Decree of the Minister of Marine Affairs and Fisheries (KEPMEN KP) No. 106/2021 concerning "Conservation Regions in the Waters of Pariaman City, West Sumatra Province". The formulation of the zoning for MAPs was carried out with an environmental approach and public consultations. Where along the coastal and small islands in Pariaman City are utilized for tourist areas without taking into account the region's function, environmental suitability, and regional carrying capacities. The zoning for MAPs was prepared for the aim of marine protection and aquatic business license based on SDGs to the government in Pariaman City.

## 2. Materials and methods

### 2.1 Research location

The research location was conducted in Pariaman City (including small islands) at coordinates 0°33'00" - 0°40'43"S and 100°10'33" - 100°10'55"E. In the administrative of Pariaman City the Northern part is bordered by V Koto Kampung Dalam Sub-district (Padang Pariaman Regency), the Southern part is bordered by Nan Sabaris Sub-district (Padang Pariaman Regency), the Eastern part is bordered by VII Koto Sungai Sariak Sub-district (Padang Pariaman Regency) and the Western part is bordered by Indian Ocean. For more can be seen in Figure 1 and Figure 2.

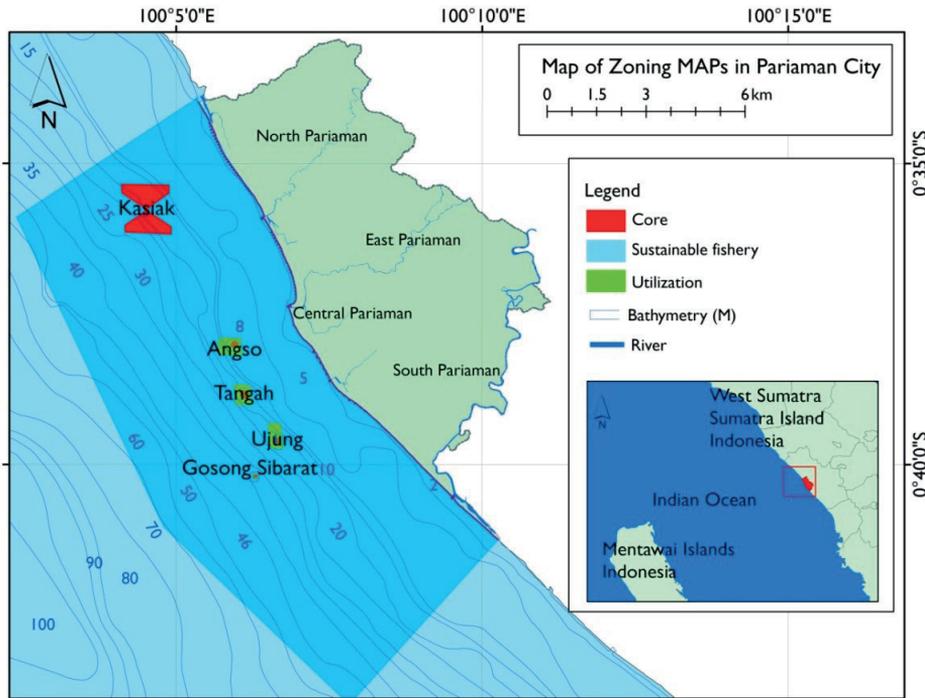


Figure 1. Map of the research location



Figure 2. Photo of the existing condition of the small islands

## 2.2 Data collection and interpretation

The method used is descriptive, which is research that describes the characteristics of the population or phenomenon being studied (Magris *et al.*, 2014; Moon *et al.*, 2016). The types of data collected consist of primary data from observations, surveys, interviews, and Focus Group Discussions (FGD). Meanwhile, secondary data come from the Agency of Geospatial Information (BIG) such as the base map sheet of the Pariaman Coastal Environmental 2012 and the map sheet of *Rupa bumi* Indonesia (RBI) Pariaman 2008, the Center of Coastal and Marine Resources Management (BPSPL) Padang, the document

of PERDA West Sumatra Province No. 2/2018, PERDA Pariaman City No. 21/2012, KEPMEN KP No. 106/2021, and the imagery of *Satellites Pour l'Observation de la Terre* (SPOT) 2020.

The making stages of the zoning for MAPs are based on the regulation of the PERMEN KP No. 30/2010 (Grantham *et al.*, 2013) using spatial, and non-spatial analysis, and criteria for suitability from the aspect of ecological, technical, and social. Meanwhile, The formulation of the zoning for MAPs, activities, and recommendations was carried out with an environmental approach and public consultations. Where along the coastal and small islands in Pariaman City

are utilized for tourist areas without taking into account the suitability and carrying capacity. The zoning for MAPs is the basis of laws, regulations, and policies for marine protection and the aquatic business license based on SDGs.

### 3. Results and discussion

#### 3.1 The zoning for MAPs in Pariaman City

Based on an analysis of the Geography Information System (GIS) in 2022, the area of coral reefs currently reaches 10.45 ha with various types of damage (Such as the impact of water pollution, garbage, unloading anchors carelessly and catching fish using explosives). Coral reefs are in a condition of good 0.34 ha, medium 1.71 ha, and damaged 6.48 ha. More details can be seen in Figure 3.

In addition to human activities, damage to marine aquatic ecosystems found at the research location is also caused by natural factors, (of them) namely climate change which causes the bleaching of coral reefs which is thought to be due to global warming factors. Based on research by Fitt & Warner

(1995); Perry et al. (2005), corals that live in symbiosis with a type of *zooxanthellaalgae* will come out of the corals because they cannot tolerate heat so the corals will die which is marked by a white color change. The climate change that is happening on earth is the result of human activities that ignore the environment (Dalby, 2013). Ferrario et al. (2014); Prarikeslan et al. (2019, 2020) explain climate change is changing the temperature of seawater with the increase in temperature, and the life of coral reefs that were originally used to constant temperatures will be threatened with damage. As for observation results on field surveys in the zoning for MAPs in Pariaman City are as follows:

- *Angso Duo* island is located at 00°38'01"S-100°05'57"E. The area of *Angso Duo* island is 5 ha. The island is uninhabited and the word *Angso Duo* itself means Goose. The utilization zone is located around the island and is used for coastal tourism and marine tourism. Additionally, Fasdiah et al. (2021) add, *Angso Duo* island has the potential for coastal tourism with a regional carrying capacities of beach tourism is 680 permits/day.

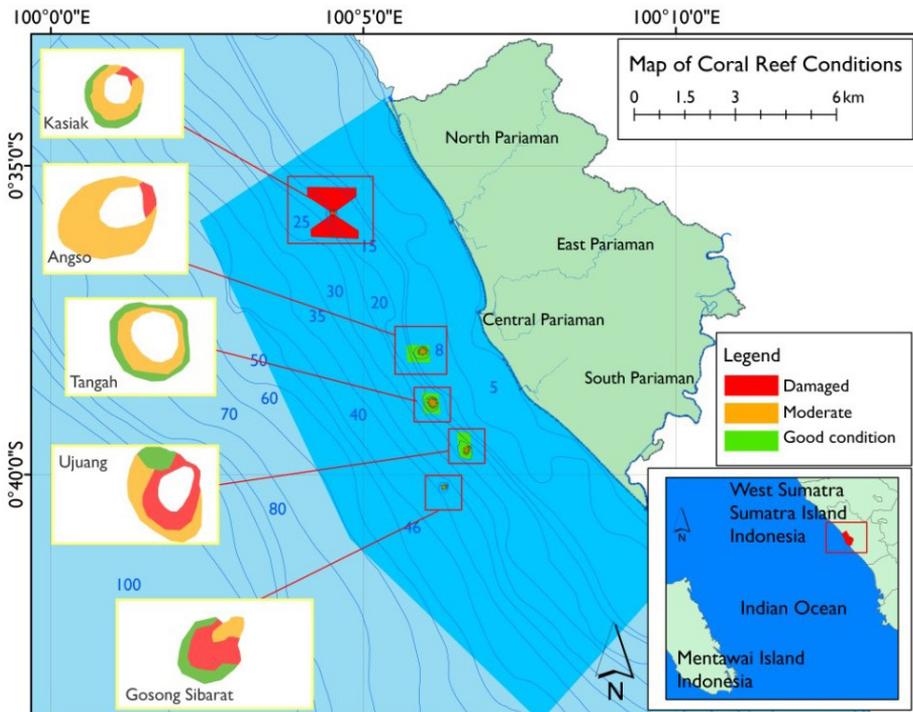


Figure 3. Map of the analysis results (coral reef) in zoning of MAPs Pariaman City

- *Tangah* island is located at 00°38'51"S - 100°06'05"E. The area of *Tangah* island is 6 ha. This island is uninhabited. The word "*Tangah*" means it is in the middle. The utilization zone is located around the island and is used for coastal tourism and marine tourism. Additionally, Aziz & Mira (2019) add, *Tangah* Island has the potential for coastal tourism with a regional carrying capacities of beach tourism is 244 permits/day.

- *Ujuang* island is located at 00°39'37"S - 100°06'39"E. The area of *Ujuang* island is 3 ha. This island is uninhabited and has flat dimensions. While the word "*Ujuang*" itself has the ultimate meaning. The utilization zone is located around the island and is used for marine tourism. *Ujuang* island has a water brightness of 25 m (Utami et al., 2018).

- *Kasiak* island is located at 00°35'47"S - 100°04'29"E. The area of *Kasiak* island is 2 ha, and this island is uninhabited. While the word "*Kasiak*" itself means sand. This island has a lighthouse and building belonging to the Ministry of Transportation. The sustainable fishery zone is located on the Western and Eastern sides of the island, where the core zone is used for turtle protection. The turtles protected namely are *Eretmochelys imbricata*, *Chelonia mydas*, and *Lepidochelys olivacea*. Sari et al. (2018) add, *Chelonia mydas* life on *Kasiak* island with texture (sand > 90%, dust 3.4 - 7.25%, clay 2 - 8%), temperature 25 - 32°C, pH 8, and salinity 33-34 ppt.

The zoning arrangement of the MAPs is carried out based on the consideration of the ecological balance of the waters referring to the PERMEN KP No. 30/2010 (Dharmadi et al., 2015). Based on these considerations, it is necessary for a government policy framework for the space utilization of coastal and small islands in Pariaman City to be prepared, to anticipate developments

that occur in the future. Based on the area region of 11,775.63 ha (the Mayor Pariaman City Decree No. 334/523/2010), the MAPs in Pariaman City it is divided into 3 zones, namely 1) core zone is 249.31 ha or 2.2%; 2) sustainable fishery zone is 11,459 ha or 97.3%; and 3) utilization zone is 67.00 ha or 0.6% of the planning regions in Pariaman City. More details can be seen in Table 1.

### 3.2 Findings from public consultations

#### 3.2.1 Activities in the core zones

The core zones is a region that must be protected and it is not allowed to change the existing conditions except those related to science, education, protection, restoration, and environment preservation. The recommended activities in this zone are in the form of conservation and restoration of the area so that the biota in this zone can breed properly. Coral reef conditions in the Southern have a live coral reef cover of 28.53 with medium conditions, while the conditions in the Northern have a live coral reef cover of 26.33% with bad conditions. According to Hermon et al. (2018); White et al. (2014), the core zone that a MAP must have is at least 2% of the total area, as an example in the Kapoposang MAP (2.16%) in Pieh Islands. Yonvitner et al. (2019); Ong (2020) added to the damage to coral reefs due to bleaching which occurred in Western Indonesian waters in mid-2016. This condition is different from the waters in Eastern Indonesia where there is still little bleaching. In addition to bleaching, fishing that is not environmentally friendly is also one of the causes of the destruction of coral reefs. For more details, activities that can and cannot be done in the core zones can be seen in Table 2.

**Table 1.** The zoning divisions for MAPs

Zones	Locations	Area (ha)
Core	<i>Kasiak</i> island	249.31
Sustainable	Sea of administrative in Pariaman City (including small islands)	11,459
Utilization	<i>Angso Duo</i> island, <i>Tangah</i> island, <i>Ujuang</i> island	67
Total		11,776

3.2.2 Activities in the sustainable fishery zones

The sustainable fishery zones is a region that has activities for protecting/preserving habitats and fish populations and rehabilitating their ecosystems which aims to support the preservation of aquatic resources. Putra *et al.* (2023) added fishing must not harm humans, damage resources, or cause conflict between fishermen. Recommended tools are lift nets, gill nets, traps, fishing rods, clamping, and wounding tools. Based on a survey in 2021 found *Heniochus Pleurotaenia* which dominates the sustainable fisheries zone. Herbivorous fish are represented by *Acanthuridae* and *Scaridae*. Carnivorous fish are represented by *Lutjanidae* and *Haemulidae*. For more details, activities that can and cannot be done in the sustainable fishery zones can be seen in Table 3.

3.2.3 Activities in the utilization zones

The utilization zones is a region that has activities for tourism, research and development, and education for the general public. The utilization zone in the MAPs in Pariaman City is used for marine tourism. Based on research by Utami *et al.* (2018), tidal conditions on the coast of Pariaman City are mixed semidiurnal and the current speed ranges from 0 - 0.03 m/s with the dominant direction perpendicular to the coast. Sari *et al.* (2018) explained that the small islands in Pariaman City are very suitable for fishing, swimming, diving, and boating tourism because the brightness, currents, waves, and accessibility support these activities. For more details, activities that can and cannot be done in the utilization zones can be seen in Table 4.

**Table 2.** Activities that can and cannot be done in the core zones

Criteria	No	Indicators	1	2	3	Instructions
Potentials	1	Marine tourism: snorkeling, diving, photos, videos, tour boats.	-	-	√	Research/education
	2	Researches: turtle egg, lola, kima, coral reefs	√	-	-	Research/education
	3	The arrest of fish/biota	-	-	√	Fish protection
Activities	1	Environmental/ecosystem restoration and rehabilitation	√	-	-	Protected by law
	2	Lego anchor	-	-	√	Protected by law
	3	Installation of FADs	-	-	√	Protected by law
	4	Cultivation activities	-	-	√	Protected by law
	5	Eliminating the function of region and utilization	-	-	√	Protected by law
	6	Natural restock	√	-	-	Protected by law

Note: Public consultations, 2022. Information: Can 1, Conditional 2, Can not 3.

**Table 3.** Activities that can and cannot be done in the sustainable fishery zones

Criteria	No	Indicators	1	2	3	Instructions
Potentials	1	Marine tourism: snorkeling, diving, photos, videos, tour boats.	√	-	-	Tourism/recreation
	2	Mainland tourism: camping, photos, outbound, turtle watching	√	-	-	Tourism/recreation
	3	Researches: turtle nesting, lola, kima, coral reef	√	-	-	Fish protection
	4	The arrest of fish/biota	√	-	-	Management of eco-friendly
Activities	1	Environmental/ecosystem restoration and rehabilitation	√	-	-	Protected by law
	2	Lego anchor	-	√	-	Protected by law
	3	Installation of FADs	√	-	-	Protected by law
	4	Cultivation activities	√	-	-	Protected by law
	5	Eliminating the function of region and utilization	-	-	√	Protected by law
	6	Natural restock	√	-	-	Protected by law

Note: Public consultations, 2022. Information: Can 1, Conditional 2, Can not 3.

3.3 Findings from activity recommendations

Based on the analysis results the entire relationship between damaged marine ecosystems with the level of knowledge, education, employment, and income of the public. The condition of the marine ecosystem according to the perception of the public living on the coast of Pariaman City is included in the medium damaged category. With these perceptions, it is necessary to solve problems related to environmental approaches and public consultations. Regarding public ignorance on the coast of Pariaman City, it can be interpreted that the perception and overall attitude of the

public toward marine resources are still low. In general, a that can be drawn from this problem is that the environmental damage and the potential of other marine resources at Pariaman City as previously described are mostly caused by human factors which are motivated by 1) a lack of public knowledge about the environment; 2) the absence of the application of the concept of environmental carrying capacity by the government of a natural area; and 3) weak law enforcement. Where in the management and activity recommendations in an integrated manner based on ecological, technical, policy, economic and social considerations are presented in Table 5.

**Table 4.** Activities that can and cannot be done in in the utilization zones

Criteria	No	Indicators	1	2	3	Instructions
Potentials	1	Marine tourism: snorkeling, diving, photos, videos, tour boats.	√	-	-	Tourism/recreation
	2	Mainland tourism: camping, photos, outbound, turtle watching	√	-	-	Tourism/recreation
	3	Researches: turtle nesting, lola, kima, coral reef	√	-	-	Research/education
	4	The arrest of fish/biota	-	-	√	Fish protection
Activities	1	Environmental/ecosystem restoration and rehabilitation	√	-	-	Protected by law
	2	Lego anchor	-	√	-	Protected by law
	3	Installation of FADs	-	-	√	Protected by law
	4	Cultivation activities	-	-	√	Protected by law
	5	Eliminating the function of region and utilization	-	-	√	Protected by law
	6	Natural restock	√	-	-	Protected by law

Note: Public consultations, 2022. Information: Can 1, Conditional 2, Can not 3.

**Table 5.** Divisions of zoning for MAPs based on activity recommendations and control in Pariaman City

No	Zones	Recommendations	Controls
1	Core	Settlements a distance of 500 m from the shoreline	Technology application and control from the government
		Establishment of a prohibited zone for fish catching, but as a marine tourism zone.	Promotion of marine tourism regions with the charm
2	Sustainable	Settlements a distance of 500 m from the shoreline	Technology application and control from the government
		Establishment of a prohibited zone for fish catching, but as a marine tourism zone.	Promotion of marine tourism regions with the charm
3	Utilization	Settlements a distance of 1 km from the shoreline	Technology application and control from the government
		The application of environmental carrying capacity for tourism activities	Technology application and control from the government
		Environmentally technology in fish cultivation	Technology application and control from the government

Note: Public consultations, 2022.

The managing problem of the resources of coastal and small islands in Pariaman City cannot be separated from the low public understanding of the benefits of natural resources. There is still a lack of knowledge of the coastal public in Pariaman City regarding the use of natural resources for non-consumptive purposes such as abrasion, flood control, aesthetics, medicine, and so on. The potential of the sea area of Pariaman City is greater than the mainland, so it is very suitable to appear as a city that makes the coastal area a leading tourist attraction. The coastline that extends from South to North has several beaches that are well known to tourists, such as 1) Sunua beach at the Southern of Pariaman City; and 2) Binasi beach, Kata beach, Cermin beach, Gandoriah beach, Pauh beach, Apar Mangrove beach, Manggung beach, Naras beach, and Belibis beach at the Northern of Pariaman City. Along this coastline, there are 53 fishing groups with an average member of 25 humans spread across 13 villages traversed by the beach. At first, they only depended on their lives as fishermen. However, with a touch of sustainable development, the fishing public can get money from other sectors such as selling food or drinks on the beach, becoming tourism actors, selling souvenirs, renting boats to tourists, and so on.

The MAPs in Pariaman City have strategic value for economic development and improving the welfare of the public. But this region is also very vulnerable to damage. If the public around the area is not educated properly and correctly, what will happen is damage to the coastal region itself, so that the ecology of the coast and sea is damaged and the welfare of the public is not achieved. Therefore, wise management is needed by placing economic interests in proportion to environmental interests, both in the short and long term. The concept of sustainable coastal region management according to Winther *et al.* (2020) is the answer to ecological problems and socioeconomic improvement of the coastal public. Furthermore, de Sá Silva *et al.* (2022) add the combination of adaptive development and integrated, environmental, economic, and social systems. The strategies and policies adopted are based on the characteristics of the coast, resources, and utilization needs.

This development is said to be sustainable because development activities are economically, ecologically, socially, and politically sustainable (Wright *et al.*, 2022). Economically sustainable because development in MAPs Pariaman City can increase the economic growth of the public. After MAPs in Pariaman City were laid out attractively and provided facilities for visitors, other economic sources emerged for the fishing public such as trading, tour guides, or even other tourism service actors. With an attractive arrangement of MAPs Pariaman City, more tourist visits and the public see it as an economic source. Then came the modern coffee shops, culinary shops, bicycle rentals, children's toys, and other shops.

Ecologically sustainable means that this development can maintain the integrity of the ecosystem, maintain the carrying capacity of the environment, and conserve natural resources including biodiversity so it is hoped that the use of resources can be sustainable. By educating fishermen to be more concerned and friendly with their marine environment as a source of livelihood, the potential of the sea can be enjoyed for a long time. Fishermen no longer destroy coral reefs because it will damage the environment and reduce fish populations, so in the near term it will have a significant impact on the economy of the fishing public themselves.

In addition to coral reef conservation, the Pariaman City Government has also carried out the conservation of turtles and mangrove forests in Apar Village. This turtle and mangrove conservation center is located in one region of the MAPs Pariaman City and has now grown into a very attractive tourist destination (Putra *et al.*, 2023). The fishing community around the MAPs, apart from catching fish in the waters of the MAPs, also hunts turtle eggs and sells them to humans for consumption. This is very bad for the sustainability of nature, especially turtles which have been designated as one of the endangered animals in Indonesia (Hanri *et al.*, 2023). Slowly but surely, educating the public about the long-term negative impacts if the turtle eggs continue to be hunted and sold. Turtles will become extinct and the balance of the natural ecosystem will be disrupted. With a direct approach to

the public, they finally understand and are willing to cooperate with the government without destroying the balance of natural ecosystems. At that time, the Pariaman City Government was very serious about turtle conservation. The Pariaman City Government established a Technical Implementation Unit (UPT) for Turtle Conservation whose task was to conserve sea turtles. Next to the turtle conservation area is a 7 - hectare mangrove forest area. Areas that were previously useless and not utilized by the local public are now being developed into attractive tourist destinations and managed by Village-owned Enterprise (BUMDes) Apar (Zaitul *et al.*, 2023; Putra *et al.*, 2023).

Furthermore, it is socially and politically sustainable, that is, a development activity should be able to create an equitable distribution of development results, public participation, public empowerment, social identity, and institutional development. At this stage, the public who have felt the impact of this development will be lifted socially and economically. Apart from that, there will also be public groups such as tourism awareness groups, the public concerned with the environment, and so on. If we continue to consistently develop development with this concept, we will get many benefits. Nature is maintained, the public economy is empowered and the public social status is lifted.

#### 4. Conclusion

The conclusion of this research is 1) Not yet increased awareness of the fishing public on the importance of aquatic ecosystems as an effort to optimize the utilization of natural resource preservation; and 2) Determination of activity recommendations that be done in each predefined zones, such as activities that may be carried out in a) the core zone is for research, ecosystem rehabilitation, and natural restocking; b) the sustainable fishery zone is for fishing and fish cultivation; and c) the utilization zone is for tourism. The recommendations from this research are the document of the zoning for MAPs, where the document is important for the government of Pariaman City as the basis for marine protection and the aquatic business license based on SDGs.

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