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Impact of tsunami Sunda Strait to coastal tourism in Tanjung Lesung Special Economic Zone Pandeglang Regency Banten Province

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Impact of tsunami Sunda Strait to coastal tourism in Tanjung Lesung Special Economic Zone Pandeglang Regency Banten Province

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Abstract. The coastal area is one of the natural magnificence that is visited by many tourists because it has unique attraction such as white sand, exotic waves, unique coral reef, and beautiful natural scenery. The natural magnificence must be maintained by a variety of damages due to human activities and natural processes such as the tsunami. The impact of the tsunami disaster, in addition to psychological trauma also had an impact on the condition of the objects of tourist attraction, which eventually led to a decline in the number of tourists. Some damage to tourist objects and attractions studied in this paper include spatial conditions, changes in the transparency of seawater on the coast and the condition of existing coral reef. The analysis was carried out by comparing the conditions before and after the impact of the tsunami at Tanjung Lesung Special Economic Zone (SEZ) in December 22th 2018. Through this analysis, it is expected that the management of coastal tourism in the after tsunami Tanjung Lesung SEZ can be carried out more comprehensive and sustainable. Therefore coastal tourism activities will still provide benefits both ecologically and economically for community, government and private administrator of SEZ.

1. Introduction

Tourism is the industry with the largest and fastest growth rate in the world [1]. The growing awareness and knowledge of the community will require priority to improve the quality of life by enjoying the natural beauty of both conservation and coastal areas. The coastal area is one of the natural beauties that are visited by many tourists because it has unique attractions such as white sand, exotic waves, unique coral reef, and beautiful natural scenery. Coastal tourism takes place where tourism and recreation at the base located on the coast and offshore. Coastal tourism is a tourist attraction that utilizes the beauty of the boundary between the land and the sea along the coastline [2]. Increased knowledge of interest in the coastal and oceanic, with easy access and technology, has an impact on the growth of activity in the coastal area [3].



The amount of recreational excursions to the coastal area needs to be improved both in terms of service and sustainability so that the coastal tourism area remains sustainable. Continuous efforts to manage coastal resources continue to be carried out so that resources and ecosystems are maintained as tourism commodities that can continue to grow and develop. An unnecessary thing to anticipate for coastal tourism is natural disasters caused by the tsunami, in order to minimize the damage that occurs in the coastal tourism area. Significant damage and loss will occur due to consideration of disaster mitigation factors in planning tourist areas. This condition is faced by the Tanjung Lesung SEZ which has a function as a tourism zone in Banten Province.

The Sunda Strait tsunami that occurred on December 22th, 2018 has devastated most of the tourism facilities in the Tanjung Lesung SEZ. The tsunami height of approximately 3 meters (Results of the Geological Agency Measurement on December 29th, 2018) has caused damage not only to tourism facilities but also ecosystems in coastal areas in Tanjung Lesung SEZ. The beauty of white sand and the coral reef which is one of the attractions in Tanjung Lesung SEZ becomes very uncomfortable to visit because of the declining quality of these resources. The impact of the damage will certainly result in the number of tourists visiting the Tanjung Lesung SEZ after the tsunami. Ecosystem damage due to the tsunami certainly causes a decrease in tourist attraction on the coast, because coastal tourism is very dependent on the condition of the ecosystem.

The aim of this paper was to determine the magnitude of the impact that occurred on the Tanjung Lesung SEZ as a coastal tourism zone due to the tsunami in December 2018. By knowing the impact is expected to provide input for local governments, especially how tourism management in Tanjung Lesung SEZ can continue. Handling the right impact will provide positive input for the management of coastal tourism in the Tanjung Lesung SEZ as a leading tourism zone in Pandeglang Regency. Management of coastal tourism in the Tanjung Lesung SEZ after the tsunami needs to get serious attention so that in the future this region will remain a leading tourist destination in Banten Province.

2. Research method

To achieve the research objectives, the method used in this study was a qualitative analysis that was comparing continuous data and models from all data and information obtained from the literature, the results of interviews, questionnaires and observation data in the field. By doing the method, some elements suggested by the literature and previous intuition can be based on evidence, while others do not. Other elements proposed at the beginning or suggested by some cases were maintained but significantly modified to match the evidence [4]. Qualitative analysis was an activity that describes the relationship between one action and another in a context similar to interpreting or explaining the meaning of the action [5].

The area of research was covering 1,500 hectares with a coastline of 13.8 kilometers as Tanjung Lesung SEZ located in Panimbang Sub District Pandeglang Regency. The information or data about attraction coastal resources and tourist activity was got from 50 tourists as respondent. Perception of respondent was needed to know their activity when they visited tourism location and attraction coastal resources relative to coral reef, island of sea, beach sand, etc. The questioner was distributed by Google form consist of 26 questioners. Meanwhile, observation for coastal resources aftermath tsunami has been done in 6 stations which were Cipenyu Beach, Bodur Beach, Resort and Beach Club, Tanjung Kuntianak Beach, Lagon Dadap Village dan Sailing Club. Observation in 6 stations to know condition of transparency seawater and coral reef such as life coral, dead coral, etc.

3. Results and discussion

3.1 Coastal vulnerability area

In the map of Banten Province disaster-prone areas in 2009 issued by the Center for Volcanology and Geological Disaster Mitigation of the Ministry of Energy and Mineral Resources of the Republic of Indonesia, that the Tanjung Lesung SEZ in Pandeglang Regency is a zone with high and moderate level of tsunami-prone area in Figure 1 (shown in red and yellow). Zones with a high level of

vulnerability and being predicted will have a tsunami height of 3 meters above ground level, so this should have been considered in planning the Tanjung Lesung SEZ Masterplan. The regional planning that has been compiled and implemented for approximately 5 years has become a mess with the tsunami on December 22th, 2018. Since its establishment as a Tourism Zone with Government Regulation Republic of Indonesia No. 26 /2012, Tanjung Lesung SEZ has prepared a leading tourism area that utilizes coastal resources as objects and attraction. The coastal attractiveness of the Tanjung Lesung SEZ included a coastline of 13.8 km with a variety of uniqueness that it has, which covers an area to the land of 1,500 hectares.

Some attractions that have been damaged due to tsunami include damage to coastal areas including sand substrate or material on the coast and coral reef that grows and develop in the oceans. According to data from the Directorate of Regulatory Utilization of the Directorate General of Control of Spatial Use and Land Control of the Ministry of Agrarian Affairs and Spatial Planning, post-tsunami Sunda Strait was approximately 60% of the damage by Tanjung Lesung SEZ. Meanwhile, PT BWJ as manager of the Tanjung Lesung SEZ states that out of the 154 hectares tourism zones that have been built, only 8 hectares were affected by the tsunami [6].

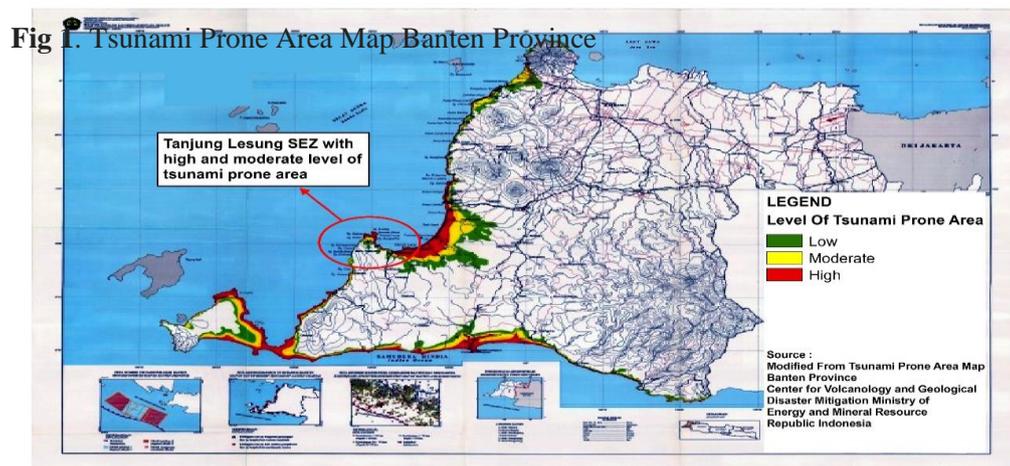


Figure 1. Tsunami Prone Area

3.2 General Situation aftermath tsunami

Destinations consist of primary and secondary resources. Primary resources are natural and human values such as climate, landscape, hospitality, tradition, culture, and heritage. Secondary resources are those related to services: accommodation, transportation, catering, shopping facilities, and others. People can observe different elements in nature, but they do not exclude each other; on the contrary, they complement each other and synergy as a travel experience [7]. While the attractiveness of destinations is the feeling and perception of a tourist who develops subjectively towards the completeness of the destination [8]. The condition of a destination is very decisive in tourism activities, especially related to attractiveness because it will provide experience for tourists who come. Natural events such as tsunamis that occurred in the Tanjung Lesung SEZ caused the condition of the destination to be damaged and undergo physical changes, especially the existing tourism facilities.



Figure 2. Condition at beach Club before tsunami (Photo taken October 8, 2018)



Figure 3. Condition at beach Club after the tsunami (Photo taken April 15, 2019)

Tanjung Lesung SEZ is located in Panimbang Subdistrict covering an area of 1,500 hectares with coastline of 13.8 km and is located at 105°38'00" -105° 41' 00" E and 06° 29' 00" - 06° 31' 00" S with management area towards the sea covering 4 miles (RZWP3K Pandeglang Regency 2014). The result of the aftermath tsunami survey, there were many changes in the SEZ destinations, for example, the condition of recreational facilities that had been carried away by the tsunami (figures 2 and 3), the beaches became dirty and poorly maintained so they were not convenient to visit.

The condition of tourism facilities damaged by the tsunami is not only at the Resort and Beach Club but also in several other destinations such as Kuntianak Beach, Bodur Beach and Copenyu Beach. Damage in the destination, now causes the cessation of tourism activities which until now look empty and uninhabited. Of the 12 existing destinations (figure 4) which were directly affected were destinations that were in the north and east of the SEZ while the destinations to the west were relatively safe from the tsunami. This happened because the east side of the SEZ directly faced the open sea while the tsunami brunt on the west was blocked by Liwungan Island which was approximately 4.6 km from the SEZ.

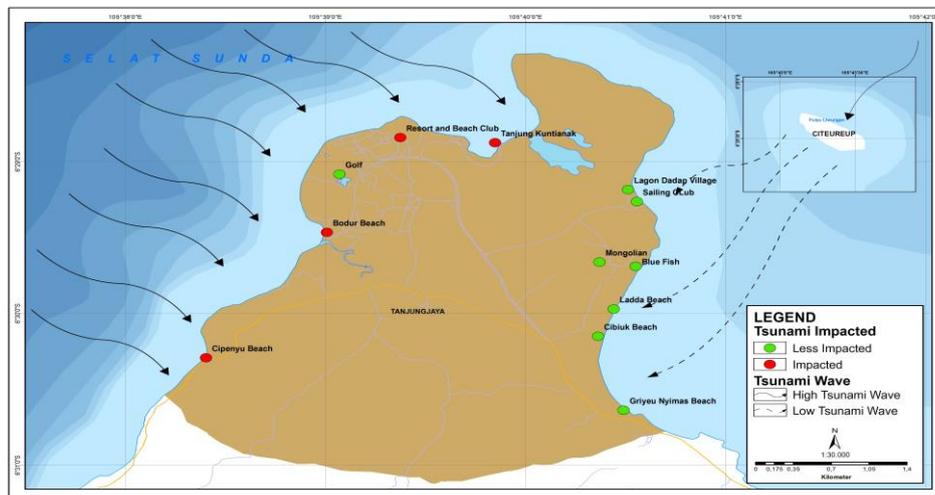


Figure 4. Destination of Tsunami Impacted in Tanjung Lesung SEZ

According to the result of interviews with SEZ managers from 1,500 hectares of Tanjung Lesung SEZ, to date only around 154 hectares have been built. The total built area, only 8 hectares or 5% affected by the tsunami. Although not all destinations in the Tanjung Lesung SEZ have been hit by the tsunami, the impact has also hit other destinations, especially causing the destination to be quiet from tourist visits. The small area and tourist destinations affected by the tsunami should not cause tourism activities in the SEZ to die and not be interesting to visit. This condition required the destination managers in SEZ to work hard and create new attractions so that they can re-grow the interest of tourists to come to the Tanjung Lesung SEZ. Thus, destinations in the SEZ after the tsunami can return to stretch and excitement and be able to realize the ideals of the Tanjung Lesung SEZ as the Main Tourism Zone in Banten Province.

3.3 Coastal water quality aftermath tsunami

Transparency is the level of intensity of sunlight entering the waters observed using a Secchi disk [9]. In natural waters, transparency is related to photosynthetic activity and primary productivity in water. Transparency is affected by the presence of dissolved particles, where more particles or organic matter dissolves, turbidity will increase. Low transparency values are caused by turbid water conditions and lack of substrate binding due to the absence of mangroves [10]. Bodies that have low transparency indicated the presence of suspended particles in these waters [11]. Transparency of the water is a condition that shows the ability of light to penetrate the water layer [12]. Transparency values are expressed in meters. Transparency is influenced by weather conditions, time of measurement, turbidity, suspended solids and accuracy at the time of measurement [9].

Based on observation, the transparency level of seawater on the coast aftermath tsunami Tanjung Lesung SEZ at 6 stations was shown in Figure 5. The transparency level of marine waters in Tanjung Lesung SEZ ranges from 3-8 m. Transparency at the 6 stations was influenced by the depth of the water. Base on observation, transparency of the water was classified into 3 which were high, moderate and low. The highest transparency was distributed at the Sailing Club and Cipenyu Beach reaches 7 meters with depths ranging from 10-15 meters. The lowest transparency was located at Lagon Dadap Village with less than 3 meters. The higher transparency value in water showed the deeper the sunlight radiation that enters the water column [13]. Transparency in the waters was one of the important factors for controlling productivity. Transparency was influenced by the level of turbidity that will affect the entry of sunlight into the waters [14].

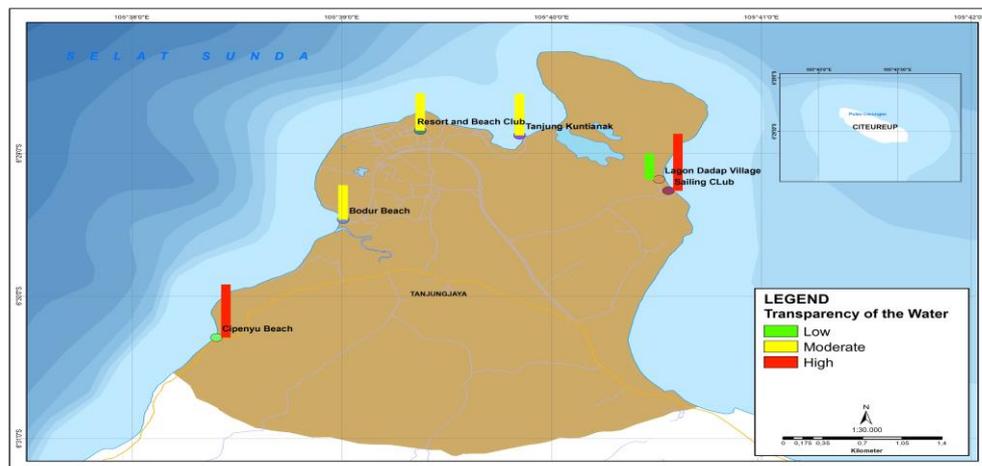


Figure 5. Transparency of the water in Tanjung Lesung SEZ

Most of the observations are still above seawater quality standards according to the Decree of the Minister of Environment No. 51 of 2004 for marine biota on a coral reef. The Ministry of Environment Decree No. 51 of 2004 stipulates that the transparency standard for marine biota > 3 meters and in the coral reef area is > 5 meters. According to Nuriya et al. (2010), the farther away from the land, the higher the water's transparency. Where waters closer to land will be affected by sedimentation input from land [11]. Transparency of the waters can also be affected by the presence of currents. The stronger the current in the water, the less sedimentation will be because it is carried by the current.

The results of the post-tsunami observations at 6 stations, it was shown that the tsunami was not significantly affected by the transparency of the seawater in the Tanjung Lesung SEZ so that it was advantageous for tourism activities. With the results of these observations, tourism activities can continue because the condition of the waters in the Tanjung Lesung SEZ was still quite supportive for tourism activities such as snorkeling and diving which were indeed quite attractive for tourists who come.

3.4 Coastal ecosystem quality aftermath tsunami

Coastal tourism activities certainly cannot be separated from the condition of ecosystems that exist in the sea such as coral reef and other marine biotas. Coral reef ecosystems have a special attraction in coastal tourism. The existence of coral reef is one of the coastal attractions in various regions of the world. A coral reef is a complex ecosystem and is typical of tropical waters. The combination of life forms in the coral reef ecosystem produces a panorama of high aesthetic value [15].

This also occurred in the Tanjung Lesung SEZ tourism zone which had a diversity of coral reef and based on the results of questionnaires on tourists (figure 6) who come to destinations in Tanjung Lesung SEZ, generally tourists who come to beach sand (38%), coral reef (13%), islands at sea (15%), marine parks (6%) and views of sunset and sunshine (28%). While tourist activities in SEZ are sightseeing (48%), snorkeling (19%), swimming (18%), diving (1%), the rest are surfing, sailing/boating, fishing, camping, and take a picture (3%).

Therefore, the existence of coral reef is one of the coastal attractions in various regions of the world including the Tanjung Lesung SEZ. Coral reef in the sea provides a big boost for tourism development throughout the tropics [16]. Although in reality, coastal tourism activities around coral reef are not always good, negative impacts can include degradation and loss of marine life through activities such as diving and snorkeling [17,18]. In addition, indirect impacts arising from unplanned coastal development, including dredging, building intertidal space, and increasing pollution and solid waste cause damage to coral reef [19,20].

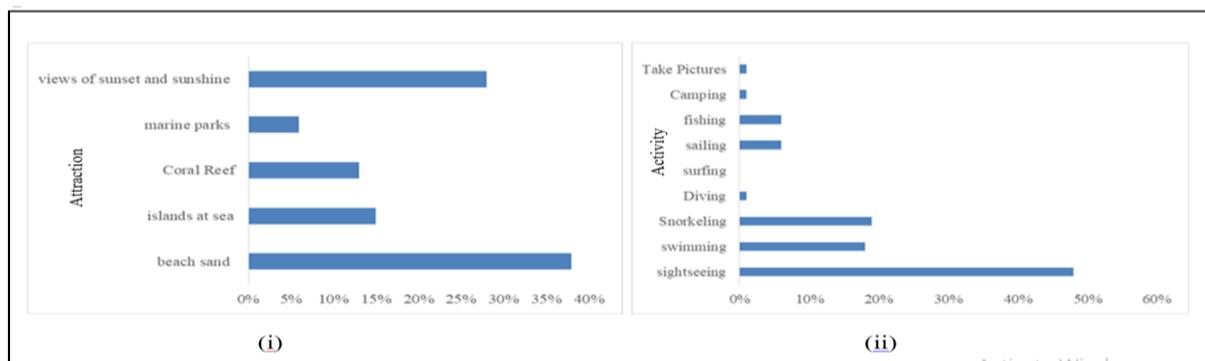


Figure 6. Perceive the value of tourism base on coastal resources (i) Perceive value of tourism attraction (ii). (n=50)

Based on the results of the latest measurements through satellite imagery by COREMAP-CTI LIPI in 2016 recorded the extent of Indonesia's coral reef reached 25,000 km² or about 10% of the world total coral reef. LIPI through the Oceanographic Research Center in 2018 noted that coral reef monitoring in bad conditions was 36.18%, enough category was 34.4%, the good category was 22.96% and the very good category was 6.56% [21]. Based on the results of research conducted at Tanjung Lesung SEZ on coral reef ecosystems, the percent coral cover is shown in figure 7.

Observation of coral reef ecosystems in Tanjung Lesung SEZ was carried out at a depth of 7 meters using the Line Intercept Transect (LIT) method. The result showed the percentage of live coral cover at 6 observation locations ranged from 10.92 - 49.74%. The highest percentage of live coral cover was at Cipenyu observation station which was equal to 49.74%. While the lowest percentage of life coral was at Tanjung Lesung observation station with a magnitude of 10.52% and the percent of abiotic closure at this station reached a value of 52.02%. A coral reef ecosystem has good conditions if its live coral cover is higher than abiotic closure. From the data obtained and used criteria, the percentage of live coral cover in 5 observation locations were included in the criteria of being moderate, except at the Tanjung Kuntianak observation station.

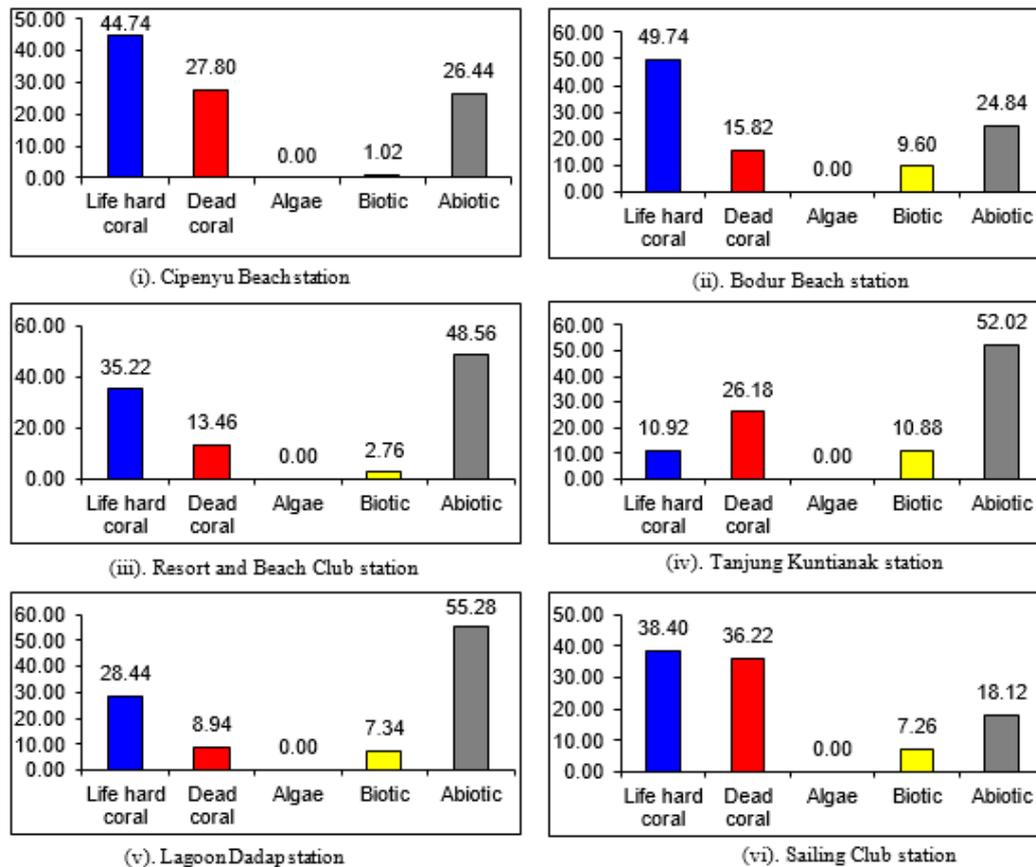


Fig 7. Condition of coral reef Aftermath Tsunami in 6 Station

The location of coral reef in Tanjung Lesung SEZ has included in the medium category with a percentage of life coral of 28.33% and the percentage of dead coral is 33.51%. The data was not much different from the results of direct observations in the field conducted in April 2019. Figure 8 shows that there were not many different conditions before and after the tsunami disaster on December 22, 2018 in the Sunda Strait. But the dead coral conditions have declined, meanwhile the abiotic has increased even though it was not too high. The tsunami disaster has more impact on the coastal ecosystem and the land in Tanjung Lesung SEZ. Therefore the uniqueness of the existing ecosystem must be kept unique and beautiful so that the interest of tourist visits to the Tanjung Lesung SEZ increases again.

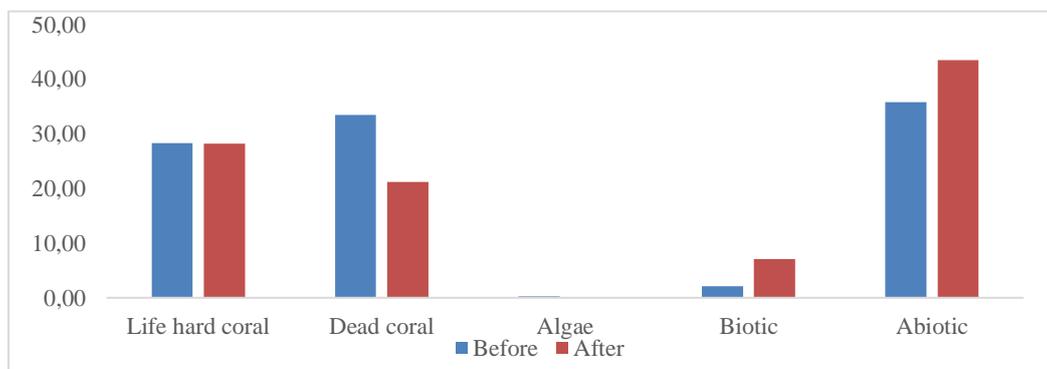


Figure 8. Condition of Coral Reef Before and After Tsunami

3.5 Coastal tourism aftermath tsunami

Since it was established as a tourism zone in 2012, Tanjung Lesung SEZ has received considerable attention from tourists. This was evidenced by the high increase in the number of tourists visiting the SEZ since 2010 - 2018 with an average increase in the number of tourist visits reaching 37.02% per year. The high number of tourist visits was, of course, not without reason, all because of the coastal attraction possessed by the Tanjung Lesung SEZ with a coastline of 13.8 km and a variety of uniqueness and attraction. Data on the number of tourists in 2018 was obtained from the Banten Province Tourism Office which was calculated until October because the data in November and December had not been inputted until the tsunami finally occurred.

Figure 9, showed that the number of tourist visits continues to grow to reach 917,072 people in 2018, although the percentage growth rate of tourist visits continues to decline and in 2017-2018 the growth rate was only 14.63%. The highest percentage of growth rate occurred in 2014-2015 which reached 59.96%, this happened because at that time Tanjung Lesung SEZ had already become widely known by local and foreign tourists. Since 2015-2018 there has been a decline in the number of tourist arrivals even though there has been a slight increase in 2017 and a return in 2018.

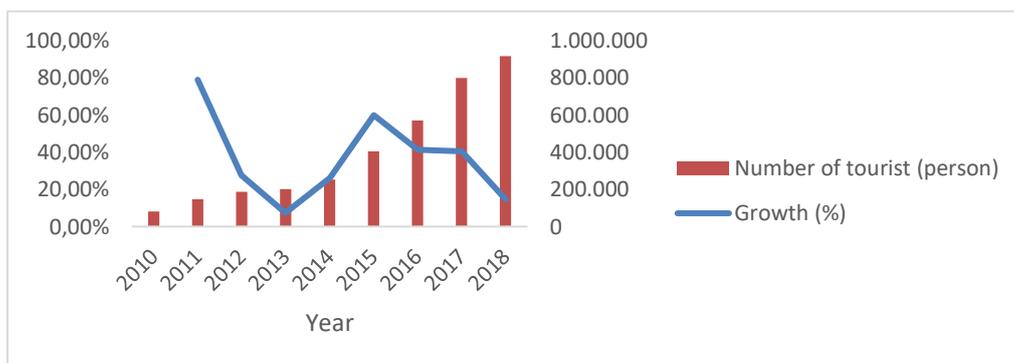


Figure 9. Number and growth of tourist visit in Tanjung Lesung SEZ 2010-2018

The decrease in the number of tourist visits was getting worse aftermath tsunami December 22th 2018. Based on interviews with Tanjung Lesung SEZ administrator, since the reopening SEZ there have been very few tourists visit, for example, the hotel room occupancy at Tanjung Lesung Resort and Beach Club was only 1-3 rooms per week until April 2019. The occurrence of a tsunami has a very significant impact on the decline in the number of tourist visits to the Tanjung Lesung SEZ. Because there were still trauma and worries felt by tourists, so they were not interested in returning to Tanjung Lesung SEZ.

3.6 Discussion

Base on the analysis, impact of the tsunami, in general, it does not affect the quality of coastal resources such as transparency conditions or coral reef in the Tanjung Lesung SEZ. The impact of the tsunami was very pronounced on the physical conditions of tourist destinations and facilities, especially for destinations that were directly affected. Tsunami waves that reached a height of 3 meters have destroyed existing tourist facilities so that it requires considerable costs for repairs.

The results of the comparison of data on coastal resource conditions before and after the tsunami indicated that only a few have changed, especially the condition of coral reef, namely the number of dead coral has decreased and the number of biotic and abiotic has increased. The percentage of dead corals decreased by 12.31% while the biotic percentage increased by 4.92% and abiotic 7.69%. The decline and increase in the number of corals after the tsunami was due to the natural growth of the coral for 5 years since the RZWP3K data collection in 2014, also the possibility of differences in the sampling location or observation station. The Sunda Strait tsunami did not have a significant effect on the quality of the water at a depth of 3 meters, more shallow than the depth at the time of sampling in

April 2019, which is 7 meters. The impact of the Sunda Strait tsunami on the Tanjung Lesung SEZ was more visible on land than in the waters.

The impact of the tsunami had the most influence on the number of tourist visits to the Tanjung Lesung SEZ, due to the trauma felt by the tourist. The decline in the number of tourists certainly has an impact on tourism activities in the Tanjung Lesung SEZ which is still in the stage of infrastructure development. To restore tourist confidence in the safety and convenience of traveling in the Tanjung Lesung SEZ, it takes a lot of effort both from the administrator and the government.

The administrator SEZ strive to continue to do damage to repair damaged facilities to return to providing tourist services. In addition to improving the condition of damaged facilities, the administrator also carries out continuous promotions through brochures, also through social media with #ayokebanten and #selatsundaaman in order to restore the image of Tanjung Lesung SEZ safe for tourist visit. Meanwhile, in destinations, administrator continues to make improvements and reconstruction even though the funds needed are not small. The improvement of existing infrastructure must continue to be carried out both in the tourism area and in the settlement of the fishing communities so that they can restore the socio-economic conditions of the people in the Tanjung Lesung SEZ. Thus the economy in the Tanjung Lesung SEZ will move again and foster the confidence of tourist and local communities to return to their normal activities.

Efforts made by Tanjung Lesung SEZ management to improve the condition of existing infrastructure, desperately need government support through the distribution of resources and promotion. After the end of the trauma and emergency phase, the Central Government in this case the Ministry of Tourism and Creative Economy continues to restore the positive image of the Tanjung Lesung SEZ through the establishment of a Safe Sunda Strait Team formed to monitor and ensure that the entire Sunda Strait tourism sector recovery program goes according to plan. The effort must continue and as far as possible avoid a vacuum in public services and management responsibilities both by the government and SEZ managers to provide protection and the best services for the community and tourists.

4. Conclusion

Based on the results of the analysis, the impact of the Sunda Strait tsunami in Tanjung Lesung SEZ was most influential to decline in the number of tourists until April 2019 due to the trauma of the tsunami hit in December 2018. The Sunda Straits tsunami, it also affected directly for tourist destinations such as Resorts and Beach clubs, Bodur Beach, Tanjung Kuntianak Beach, and Cipenyu Beach especially to tourism facilities which were severely damaged.

Meanwhile, the impact of the tsunami did not significantly affect live seawater transparency and coral reef conditions, it was based on the results of a survey on 6 observation stations. According to these conditions, it was certainly necessary to make efforts to restore the positive image that destinations in Tanjung Lesung SEZ were safe to be visited and still have attractions in the form of the beauty of the beach and sea views. Cooperation between Government and administrator was urgently needed to revive coastal tourism in the Tanjung Lesung SEZ and realizing the initial goals of SEZ development as the center of regional economic growth.

References

- [1] Wall G 2007 Tourism in the coastal zone: perspectives from Hainan, PR China *J. Reg. Anal. Policy* **37** 193–8
- [2] Halim H S 2016 Co-management: Valuating Social Communication of Sustainable Coastal Tourism, in Indonesia *Int. J. Mar. Sci.* **6**
- [3] Moreno A and Amelung B 2009 Climate change and coastal & marine tourism: review and analysis *J. Coast. Res.* 1140–4
- [4] Bryman and Alan 2012 *Social Research Methods* (New York: Oxford University Press Inc)
- [5] Williams M 1976 Symbolic interactionism: fusion of theory and research ‘, in DC Thorns (ed.) *New Directions in Sociology*, London: David & Charles

- [6] Tempo.co.id. 2018 <https://bisnis.tempo.co/read/1159105/pasca-tsunami-perbaikan-kek-tanjung-lesung-ditanggung-pengelola>
- [7] Formica S and Uysal M 2006 Destination attractiveness based on supply and demand evaluations: An analytical framework *J. Travel Res.* **44** 418–30
- [8] Pallavicini J A C 2017 Factors influencing tourism destinations attractiveness the case of Malaga
- [9] H E 2003 *Telaah Kualitas Air* (Yogyakarta: Kanisius)
- [10] Mainassy M C The Effect of Physical and Chemical Parameters on the Presence of Lompa Fish (*Thryssa baelama* Forsskål) in the Apui Coastal Waters of Central Maluku District *J. Perikan. Univ. Gadjah Mada* **19** 61–6
- [11] Hamuna B, Tanjung R H R, Suwito S, Maury H K and Alianto A 2018 Kajian Kualitas Air Laut dan Indeks Pencemaran Berdasarkan Parameter Fisika-Kimia di Perairan Distrik Depapre, Jayapura *J. Ilmu Lingkungan.* **16** 35–43
- [12] Nuriya H, Hidayah Z and Syah A F 2010 Analisis Parameter Fisika Kimia di Perairan Sumenep Bagian Timur dengan Menggunakan Citra Landsat TM 5 *J. Kelaut. Indones. J. Mar. Sci. Technol.* **3** 132–8
- [13] Juliana 2007 *Kelimpahan zooplankton serta hubungannya dengan parameter fisika, kimia, dan biologi di Pantai Indah Kapuk, Kapuk Muara, Perairan Teluk Jakarta* (Institut Pertanian Bogor)
- [14] G D 2012 *Kualitas Perairan Pantai Pulau Batam, Kepulauan Riau berdasarkan karakteristik fisika-kimia dan struktur komunitas plankton* (Institut Pertanian Bogor)
- [15] Damar A and Wardiatno Y 2012 Kondisi Terumbu Karang di Perairan Pulau Tegal dan Sidodadi Kecamatan Padang Cermin Kabupaten Pesawaran Provinsi Lampung *Maspari J. Mar. Sci. Res.* **4** 46–57
- [16] Hawkins J P and Roberts C M 1994 The growth of coastal tourism in the red sea: Present and future effects on coral reefs. *Ambio* **23** 503–8
- [17] Hasler H and Ott J A 2008 Diving down the reefs? Intensive diving tourism threatens the reefs of the northern Red Sea *Mar. Pollut. Bull.* **56** 1788–94
- [18] Lamb J B, True J D, Piromvaragorn S and Willis B L 2014 Scuba diving damage and intensity of tourist activities increases coral disease prevalence *Biol. Conserv.* **178** 88–96
- [19] Wongthong P and Harvey N 2014 Integrated coastal management and sustainable tourism: A case study of the reef-based SCUBA dive industry from Thailand *Ocean Coast. Manag.* **95** 138–46
- [20] Liu P-J, Meng P-J, Liu L-L, Wang J-T and Leu M-Y 2012 Impacts of human activities on coral reef ecosystems of southern Taiwan: a long-term study *Mar. Pollut. Bull.* **64** 1129–35
- [21] LIPI P P O 2018 LIPI: Status terkini terumbu karang Indonesia 2018 *LIPI. Pus. Penelit. Oseanografi*