The tsunami prone area for marine tourism activities (case study: Tulungagung District)

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Abstract. Tulungagung District is one of the regions that has a coastal area that is used for various activities, one of which is marine tourism. Tulungagung District is located directly facing the Indian Ocean has the potential for a disaster, especially a tsunami. The level of tsunami disaster risk in coastal areas and sea space in which the majority is used for tourism can result in loss of life, treasure, and property for people who live on the coast. This study identifies the use of marine and coastal space, especially for marine tourism activities and analyzes the level of risk based on the area that has the potential to threaten the tsunami disaster. This study resulted in a very high-risk area affected by the tsunami disaster with the top regions, namely in Besole Village which is used for Popoh Beach tourism, Sidem Beach, Fishing Port, settlement, aquaculture, and Floating Net Cages with the area affected the impact is 55,536 ha. Equipped with an evacuation route to the gathering point and TEA (Final Evaluation Place).

1. Background

The Unitary State of the Republic of Indonesia is an archipelago characterized by an archipelago with areas whose boundaries and rights are stipulated by Law Article 25. For the stipulation of these rights, it is regulated in Law No. 1 of 2014 concerning the Management of Coastal Areas and Islands Small [1]. In-Law Number 1 Year 2014 states that the Management of Coastal Areas and Small Islands is a coordinating plan, utilization, supervision, and control of coastal and small island resources carried out by the Government and Regional Governments, between sectors, between ecosystems land and sea, and between science and management to improve people's welfare.

Tulungagung District is one of the areas on the south coast of East Java whose coastal areas are used for various activities including marine tourism. But the area which is located directly adjacent to the Indian Ocean has a history of earthquakes so that the potential for a disaster, especially a tsunami, because the South Coast region of Java Island, including Tulungagung District, is located in the meeting of the Indo-Australian plate [2]. The level of tsunami disaster risk in the coastal and marine areas of Tulungagung District which is mostly used for tourism activities can result in loss of life, property, and objects for tourists when traveling and people living on the coast. Therefore, this tourism area needs to be studied which takes into account the high level of tsunami risk. The purpose of this study was to find out the results of an inventory of the use of marine and coastal spaces, especially those used for marine tourism activities to the level of disaster-prone risks obtained from the area potentially affected by the tsunami disaster and associated with evacuation routes and gathering points.
The southern region of Tulungagung District is a coastal area that is known to have a coastline of 48.597 km which is divided into four coastal districts, namely Besuki, Tangunggunung, Kalidawir, and Pucanglaban District. In these four sub-districts, nine villages are belonging to coastal villages because they are directly adjacent to the Indian Ocean [3].

2. Metodology

2.1. Study area
This study was performed at the area of Tulungagung District (7°51’-8°18’ S and 111°43’-112°07’ E).

2.2 Data processing

2.1.1 Data collection
Data used in this research were RZWP-3-K Map East Java to be taken in the Tulungagung District Scale 1:250.000 in 2016, KSP Map Scale 1:150.000 in 2015, Tsunami Risk Map Scale 1:45.000 in 2015, an existing survey in 2019 and Administrative Boundary Tulungagung District.

2.1.2 Inventory planning document
The RZWP-3-K map was carried out in an inventory of utilization in the marine and coastal spaces in Tulungagung District. Existing condition survey data is overlaid on the location of marine tourism following the planning documents on the Map of KSP (Strategic Tourism Zone). The tsunami hazard map was carried out an inventory of the risk of the tsunami disaster and evaluated the area at risk of tsunamis on the coast of Tulungagung District.

2.1.3 Overlay data
From the inventory of the RZWP-3-K Map, an overlay with the Tulungagung District boundary was conducted to produce a map of the utilization of the sea and coastal space of the Tulungagung District. Existing condition data is overlaid with KSP maps to produce suitability of existing marine tourism locations with planning documents in the form of Map KSP. Then from the map of the utilization of the sea and coastal space of Tulungagung District and the the suitability of the location of marine tourism, an overlay was conducted with the results of the inventory of the level of tsunami disaster risk. From the results of the overlay, a tsunami disaster risk map was generated at the location of the marine tourism in Tulungagung District.

2.1.4 Analysis
The tsunami disaster risk map in the location of the Tulungagung District marine tourism site was analyzed on the level of tsunami disaster risk in the coastal area of Tulungagung District, which was used as a marine tourism activity.

3. Result and discussion

3.1 Utilization of sea and coastal spaces in Tulungagung District
This study resulted in an inventory of the use of marine resources in the area of marine and coastal spaces, in addition to marine tourism is also used for other uses by the surrounding community. Table 1 below is the utilization of marine resources in the coastal area obtained from the inventory of the RZWP-3-K map of Tulungagung District and field surveys.
Table 1. Utilization of marine resources.

| No. | Name of Village in Coastal | Utilization |
|-----|---------------------------|-------------|
| 1   | Keboireng                | Marine tourism (Gemah Beach, Klatak Beach Bayem Beach, Nglarap Beach), stand, fishing settlements, capture fisheries. |
| 2   | Besuki                    | Widodaren Beach, rainfed rice fields, settlements. Marine tourism (Popoh Beach, Sidem Beach, Coro Beach, Banyu Mulok Beach), stand, fishing settlements, Popoh Fish Auctions (TPI), Floating Net Cages (KJA), capture fisheries, fishing, port, lodging, buildings performances and conservation areas. |
| 3   | Besole                    | Marine tourism (Brumbun Beach, Gerangan Beach, Sawah Ombo Beach, Sioro Beach), floating houses, fishing settlements, fishing boats, capture fisheries, and conservation areas. Marine tourism (Sanggar Beach, Ngalur Beach, Patok Gebang Beach) and conservation areas. |
| 4   | Ngrejo                    | Nautical Tourism (Sine Beach), fisherman settlements, stalls, TPI, capture fisheries and conservation areas. |
| 5   | Jengglinoshoaro              | Marine tourism (Sanggar Beach, Ngalur Beach, Patok Gebang Beach) and conservation areas. |
| 6   | Kalibatur                  | Nautical Tourism (Sine Beach), fisherman settlements, stalls, TPI, capture fisheries and conservation areas. |
| 7   | Rejosari                   | Tourism Dlodo Kalidawir Beach, coconut plantation, settlement. |
| 8   | Panggungkalak              | Marine Tourism (Dlodo Pucanglaban Beach), coconut plantation, settlement. |
| 9   | Pucanglaban                | Marine Tourism (Kedung Tumpang, Molang Beach, Lumbung Beach). |

Viewed from Table 1, from the 9 villages located on the coast, all of them have coastal tourism. Of all the beaches that have been used for tourism in all villages except Besuki Village. In Besuki Village there is a beach, Widodaren Beach, but there is no beach that manages, only visitors around the area who want to find fish.

Of the 9 villages, 8 coastal villages besides being used for tourism are also used for settlements, capture fisheries and fishing ports, and conservation areas. One other village is Pucanglaban village, Pucanglaban Subdistrict, the coast is not used as a settlement because of unopened road access and no electricity network.

The most dominant use of the marine space is used for capture fisheries and aquaculture, while the most dominant coastal uses are mostly for tourism activities and a small portion for settlements. So that
from the utilization it can be concluded that the utilization of sea and coastal space is following RZWP-3-K, because most of the marine space is used for fishing activities, aquaculture, ports, etc. While for the coast most of it has been utilized for tourism activities which as a coast should have a high attraction with the presence of beaches. The following is a map of the results of an inventory of marine and coastal space utilization in Tulungagung District.

![Map of utilization of sea and coastal spaces in Tulungagung District.](image)

**Figure 1.** Map of utilization of sea and coastal spaces in Tulungagung District.

With the following information:

3.2 Existing conditions and map of KSP (tourism strategic area)

According to existing conditions, the location of marine tourism can be seen in Figure 2 below:
Figure 2. Identification of utilization of existing sea and coastal spaces.

With the following information:

From Figure 2 it can be seen that the utilization of sea space with a limit of 4mil from the coastline is not only used as a tourism area, but also used for other areas such as marine biota migration, conservation areas, aquaculture, and capture fisheries, and PPIs (Fishing Port). From the survey of the existing conditions, it is also known that 14 locations on the coast are used as marine tourism.

The results of the overlay of planning documents with the existing produce marine tourism locations contained in the Ripparda document in the KSP Map and the existing conditions result in the suitability of the existing conditions with the planning documents in Figure 3 as follows.
Figure 3. Conformity of tourism locations existing conditions with planning documents.

From Figure 3 it can be seen that the location of marine tourism in existing conditions is in the area planned by the local government, namely KSP (Zone of Tourism Strategy), then from the statement, it can be concluded that the existing tourist sites obtained from field surveys in accordance with the planned area government.

Can be seen in the Strategic Zone of Tourism which is divided into three KSP, namely KSP IV A, KSP IV B, and KSP IV C. In KSP IV A there are 8 locations namely Klatak Beach, Gemah Beach, Bayem Beach, Sidem Beach, Popoh Beach, Coro Beach, Brumbun Beach, and Gerangan Beach. KSP IV B has 3 locations, namely Sanggar Beach, Ngalur Beach, and Sine Beach. As well as KSP IV C, there are 3 locations, namely Dlolo Kalidawir Beach, Dlodo Pucangaban Beach, and Kedung Tumpang Beach.

3.3 Tsunami disaster risks at marine tourism locations

In the results of tsunami disaster risk research in marine tourism locations, all marine tourism locations are in a tsunami hazard zone with a high to very high-risk level. The following is the appearance of the tsunami disaster risk area at the marine tourism site:
Figure 4. Tsunami disaster risks at marine tourism locations.

With the following information:

Table 2. An area in coastal village.

| No. | Village on the coastal | Marine tourism          | Area of tsunami risk (Ha) |
|-----|------------------------|--------------------------|---------------------------|
| 1   | Keboireng              | - Gemah Beach            | 22,209                    |
|     |                        | - Klatak Beach           |                           |
|     |                        | - Bayem Beach            |                           |
| 2   | Besuki                 | - Popoh Beach            | 16,298                    |
|     |                        | - Sidem Beach            |                           |
| 3   | Besole                 | - Coro Beach             | 55,536                    |
|     |                        | - Brumbun Beach          |                           |
| 4   | Ngrejo                 | - Gerangan Beach         | 40,587                    |
|   | Location                      | Beach Name              | Area  |
|---|------------------------------|-------------------------|-------|
| 5 | Jengglungharjo               | - Sanggar Beach         | 32,713|
|   |                              | - Ngalur Beach          |       |
| 6 | Kalibatur                    | Sine Beach              | 38,687|
| 7 | Rejosari                     | Dlodo Kalidawir Beach   | 22,365|
| 8 | Panggungkalak                | Dlodo Pucanglaban Beach | 7,944 |
| 9 | Pucanglaban                  | Kedung Tumpang Beach    | 25    |

From Table 2, it can be seen that from the area at risk of a tsunami disaster, the marine tourism location that has a very high risk of the tsunami is in Besole Village, followed by Ngrejo Village and Kalibatur Village. Of the 14 marine tourism locations obtained from field surveys and documents, all indicated are in the tsunami hazard risk zone with a very high level of risk as indicated in red. Areas outside the tourist area are indicated to be in a tsunami risk zone with a high level of risk indicated by pink. And for green is an area that is low against the risk of tsunami hazard.

The tourist sites that are prone to disasters are equipped with evacuation routes and gathering points which will be displayed in Figure 5. The beaches are in a very high-risk area of the tsunami because all of their areas face directly towards the Indian Ocean.

![Figure 5](image_url)

**Figure 5.** Evacuation paths and gathering points in the coastal district of Tulungagung.

With the following information:

4. Conclusion
From the research, it can be concluded that:

- The utilization of marine and coastal spaces in Tulungagung District besides being used for tourism is also used for other uses such as conservation areas, capture fisheries areas, aquaculture areas, marine biota migration areas, and fishing ports.
- According to the existing conditions, the location of marine tourism is now entirely by the planning on the Ripparda document in the Map of KSP (Strategic Tourism Zone).
- All marine tourism locations are indicated to be in the tsunami hazard risk zone, the most at-risk sites are in Besole Village, Ngrejo Village, and Kalibatur Village with very high-risk levels according to the 2015 Tsunami Risk Map Scale 1: 45,000 from BPBD (Disaster Management Agency Area) Tulungagung District.

5. References

[1] Astor Y, Sulasi W N, Hendriatiningsih and Wisayantono D 2014 *Konstruksi integrasi unsur-unsur pemanfaatan laut wilayah Indonesia dalam perspektif kadaster kelautan*. Bandung: Politeknik Negeri Bandung

[2] Koswara, Arwi Yudhi, etc 2015 *Studi resiko tsunami di wilayah pesisir selatan Kabupaten Malang*. Surabaya: ITS

[3] Dinas Kelautan dan Perikanan Provinsi Jawa Timur 2016 *Profil desa pesisir Jawa Timur (volume 2: pesisir selatan)* Surabaya

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