

# Causes of Coastal Erosion and Environmental Damage on the Sowan Beach of Tuban District

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## Abstract

Beaches in Tuban district consist mainly of rocky, sandy, muddy, and biogenic beaches (mangroves and corals) with a beach length of 65 km. Factors that cause coastal erosion and environmental degradation in coastal areas are due to natural and human activities. Management policies that ignore the degradation of the coastal environment will result in misleading policies. The purpose of this study is to identify the causes of erosion and damage to the environment of Sowan beach which is a coastal tourist attraction in Tuban Regency. Coastal vulnerability assessment was done by using scoring on seven parameters of human activities. Primary data to determine population activities that influence erosion and damage to the coastal environment was done by distributing questionnaires randomly to 100 communities around Sowan Beach. Based on the results of the Sowan beach vulnerability scoring because human activities indicate conditions that are very vulnerable, a strategy is needed to reduce human activities that are detrimental to Sowan's coastal environment. The results of the vulnerability score of Sowan Beach caused by human activities indicate that conditions are very vulnerable, so a strategy is needed to reduce human activities that are detrimental to Sowan's coastal environment. The results of the vulnerability score of Sowan beach caused by human activities indicate that conditions are very vulnerable, so a strategy is needed to reduce human activities that are detrimental to Sowan's coastal environment. Based on community perceptions, there are 4 destructive human activities; the absence of coastal protection (30%), the presence of wild sand mining (35%), tourism activities themselves (20%) and capture fisheries activities (15%).

**Keywords:** Coastal Vulnerability Assessment, Tourism, Human Activities

## INTRODUCTION

Coastal erosion is a worldwide marine hazard, because it not only causes loss of land on the coast, beach and tidal zones

but also damages infrastructure facilities in coastal areas, induces sea water intrusion and flood hazards. The study of coastal erosion in developed countries began in the early 20th century. (Micallef *et al*, 2018; Toimil *et al*, 2017; Matthews *et al*, 2017)

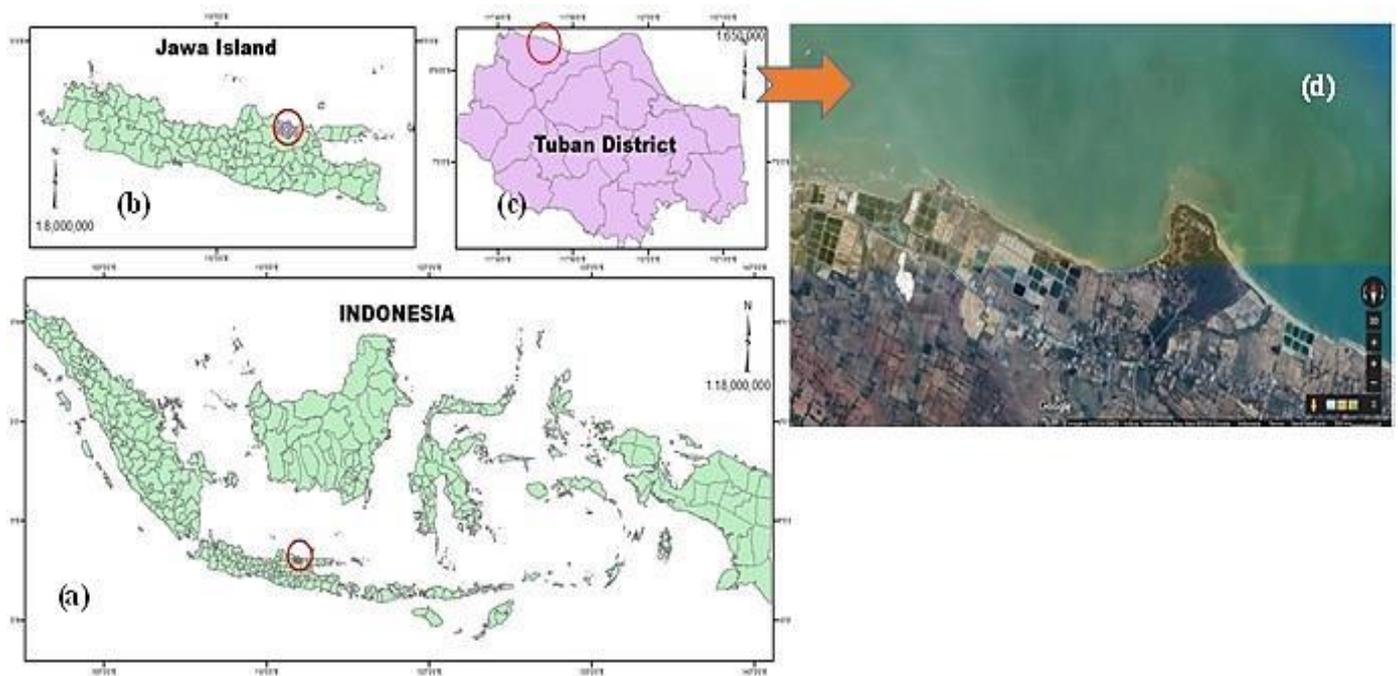
Coastal erosion is caused due to natural factors such as waves action, tidal currents, wind (Escudero-Castillo *et al*, 2018; Pikelj *et al*, 2018) and also due to human activities (Pagán, *et al* 2016; Chen, & Bau, 2016). The concept of coastal erosion is the process of eroding coastal constituent material by waves and the scraped material is transported elsewhere by the current. From the point of view of the balance of interactions between forces originating from land and forces emanating from the sea, coastal erosion occurs because the forces originating from the sea are stronger than the forces originating from the land and are destructive in nature. Coastal erosion can also be caused by sea level rise (Taborda & Ribeiro, 2015; Joesidawati *et al*, 2017; Joesidawati & Suntoyo, 2017; López-Dóriga *et al*, 2019)

Such erosion can cause a reduction in the coastal area, especially the area closest to sea water. If this is allowed to continue, abrasion will erode all coastal areas so that the seawater will inundate all coastal areas and population settlements, Bhattachan *et al*, 2018), eliminate coastal biodiversity (López-Dóriga *et al*, 2019) and ecological balance (Yang & Chui, 2017) and pose a danger both directly and indirectly to human life and the natural environment (Carless *et al*, 2017). It has been reported that 70% of the world's sandy beaches are eroding (Bird *et al.*, 1985).

The beaches in Tuban district consist mostly of rocky, sandy, muddy, and biogenic beaches (mangroves and corals). Sandy beaches and muddy beaches are two basic types of beaches consisting of alluvial land (Joesidawati, 2016). The danger of coastal erosion is mainly distributed in these two types of beaches, where on both types of coastline the average coastline decline is 0.13 m/yr. (Joesidawati and Suntoyo, 2016)

## MATERIALS AND METHODS

### Study Area



**Figure 1** (a) Research location on the map of Indonesia (b) Research sites on the island of Java, precisely Tuban District (c) Research sites in Tuban District (d) Location of research around the coast of Sowan Beach



**Figure 2.** Location points (70 location points) for observing the causes of coastal erosion

Based on Figure 1. Around Sowan Beach is located in Tuban Regency, East Java Province, Indonesia, precisely at coordinates  $6^{\circ} 46'30.06''$  S,  $111^{\circ} 46'11.18''$  E and  $6^{\circ} 46'15.78''$  S,  $111^{\circ} 44'57.02''$  E with a beach length of 3.5 km

where there are 70 locations that are 50 m away from one point to another.

**Data Collection and Data Analysis**

Primary data to find out the livelihood activities of the population that influence coastal erosion, as well as identify population perceptions of coastal erosion that occurs, and tourism-related activities at the research site. Primary data was carried out by distributing questionnaires randomly to 100 residents around Sowan beach. Furthermore, simultaneous

field observations were carried out with questionnaire surveys to determine the causes of erosion around the study area.

Coastal vulnerability index assessment based on human activities (7 parameters) grouped in 5 classes; invulnerable, low vulnerable, moderately vulnerable, vulnerable and highly vulnerable (Table 1)

**Table 1.** Coastal Vulnerability Assessment based on Human Activity Parameters

No	Parameter	Value/vulnerability classes				
		Invulnerable	low vulnerable	moderately vulnerable	vulnerable	highly vulnerable
		1	2	3	4	5
1	Sand mining	>80%	60-80%	40-60%	20-40%	<20%
2	Coastal reclamation	<5%	5-20%	20-30%	30-50%	>50%
3	Ground Water Consumption	>20%	20-30%	30-40%	40-50%	>50%
4	Land use pattern	Protected area	Unclaimed area	settlement	Industry	Farming
5	Natural protection against degradation	>80%	60- 80%	40- 60%	20 -40%	<20%
6	Coastal protection structure	>50%	30- 50% 2	20- 30%	5 - 20%	<5%
7	Watershed	Not affected		Moderately affected		Highly affected

Source :Joesidawati, (2016)

The chi square method is used as an analysis of data collected based on the results of the questionnaire, and descriptive analysis describes the results of the questionnaire (Senevirathna et al, 2018).

**RESULTS AND DISCUSSION**

The cause of coastal erosion which leads environmental damage on coastal areas around Sowan Beach, Bancar is human activity. Joesidawati (2016) analyzed the vulnerability of Tuban beach due to the impact of SLR (Sea Level Rise)

using 6 parameters; sand mining, coastal reclamation, groundwater consumption, land use patterns, protection of nature, coastal structures. Human activities can increase the negative impact of rising sea levels and also have an impact on the amount of erosion on the coast of Tuban district. However, in this study, seven parameters were added, including the presence or absence of data on watersheds in the study location. The erosion conditions around the Sowan Beach are based on field observations as shown in Figure 3



**Figure 3.** Multiple Point Samples Location of 2017 Field Observation Results on Beach Erosion Conditions along Sowan Beach ( $\pm 3.5$  km) (12 points from 70 points)

**Assessment Coastal Vulnerability Index Based on Seven Human Activity Parameters**

**1. Sea- sand Mining**

Illegal sea-sand mining in Tuban district occurs in three sub-districts of coastal area; Bancar , Tambakboyo, and Jenu with a length of beach at the mine is 5420.23 m / 5.4 km.. Compared to the length of the coast of Tuban Regency ( $\pm 65$  km), the location used as illegal mining is 8.48% (Joesidawati,

2016). Illegal sea-sand mining can affect coastal areas to be more vulnerable (Ozyurt, 2007). Figure 4 shows the illegal sand mining around the Sowan beach the research location) is located in Bogorejo village. The production of sea-sand in the mine are coordinated by sea-sand middlemen.



**Figure 4.** Illegal sand mining around Sowan Beach (Bogorejo Village)

Illegal sand mining around Sowan beach is 856.25 m or 30.98% of the length of the coast of Bogorejo Village, Bancar District. The beach vulnerability index using the vulnerability class from Joesidawati (2016) shows that sand mining in Sowan falls into the category of "vulnerable" class

## 2. Beach Reclamation

There was no beach reclamation carried out by the community around Sowan beach, this means the class of vulnerability around Sowan beach in the class "invulnerable"

## 3. Groundwater consumption

In this research area, clean water needs use two sources, it comes from sources originating from local water supply utility and natural resources in the form of private or village-managed wells. Based on data on groundwater consumption around Sowan Beach, it shows that 50% is used for agricultural irrigation and shrimp ponds. Whereas for the consumption of drinking water and the daily needs of the residents around Sowan Beach use the local water supply utility. The source of clean water for local water supply utility comes from several sources, it comes from spring and artesian wells. This condition indicates that groundwater consumption exceeds 50% or in the class "very vulnerable". Figure 5. Shows the location of artesian wells for agriculture around the Sowan Beach, the distance between one artesian wells to another is  $\pm 50$  m.



**Figure 5.** (a) The distance from the artesian wells along the Sowan coast is  $\pm 200-300$  m from the shoreline and (b) the distance between the artesian wells is  $\pm 50$  m

## 4. Land Use Pattern

Land use pattern in the study location was seen at a distance of 300 meters from the shoreline as shown in Figure 6

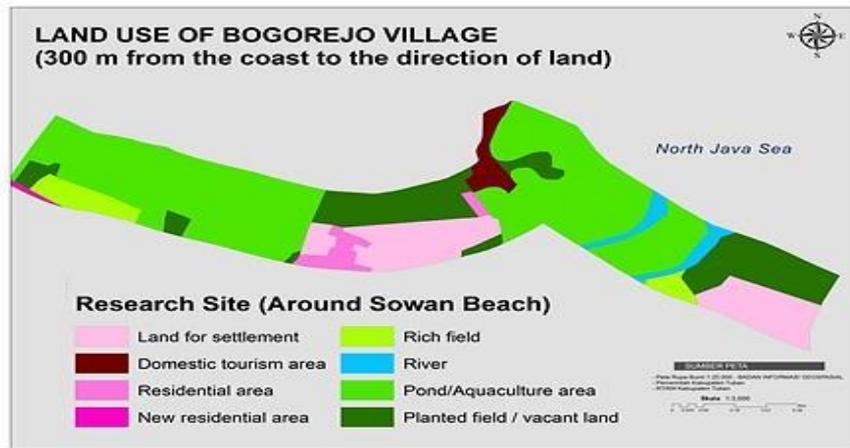


Figure 6. Land Use of Research Sites

Figure 6 shows planted field / vacant land 153,854.54 m<sup>2</sup>, domestic tourism area = 20,995.61 m<sup>2</sup>, rice field = 34,235.30 m<sup>2</sup>, pond = 423,640.15 m<sup>2</sup>, river = 21,549.06, land for settlement = 145,885.86 m<sup>2</sup>. Based on the vulnerability class, this region shows the class of "vulnerable" this is because the agricultural area is 76.45% or 611,729.99 m<sup>2</sup>, residential area 18.23% or 145,885.86 m<sup>2</sup>, protected area 2.62% or 20,995.61 m<sup>2</sup>, unclaimed area of 2.69% or 21,549.06 m<sup>2</sup>

#### 5. Natural protection against degradation

Natural protection against degradation according to Dahuri (2003) indicates the presence or absence of key habitats (coral reefs, seagrass beds, and mangrove forests). The existence of tropical marine ecosystems can maintain economic stability in coastal areas throughout the world. (Hoegh-Guldberg *et al*, 2009; Foale *et al*, 2013). In the study location there was no natural protection so that it can be included in the class "highly vulnerable"

#### 6. Coastal Protection Structure

One of the ways to overcome coastal erosion is by building a coastal protection building (jetty, groynes, breakwater, beach wall or revetment). With the building protruding or parallel to the coastline, it will certainly have an influence on the shape of the existing coastline. Coastal protection structure at the study site which has been built from 2013-2015 by the regional government of Tuban, or by the community, which is only 314.43 m or 11.38% of the coastal length of the research site (2,763.94). This condition shows that the class is "highly vulnerable"

#### 7. Watershed

The watershed around the coast of Sowan is subwatershed Budur (Figure 7).

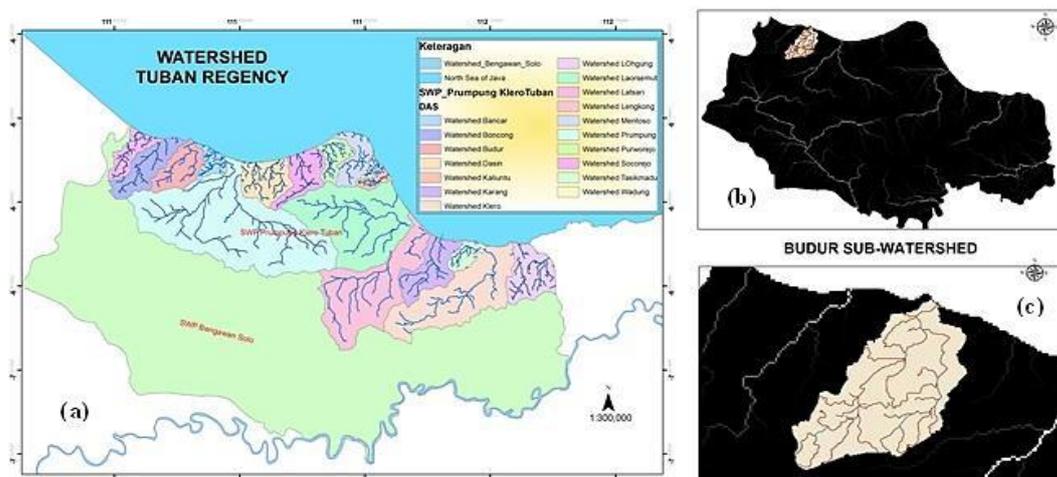
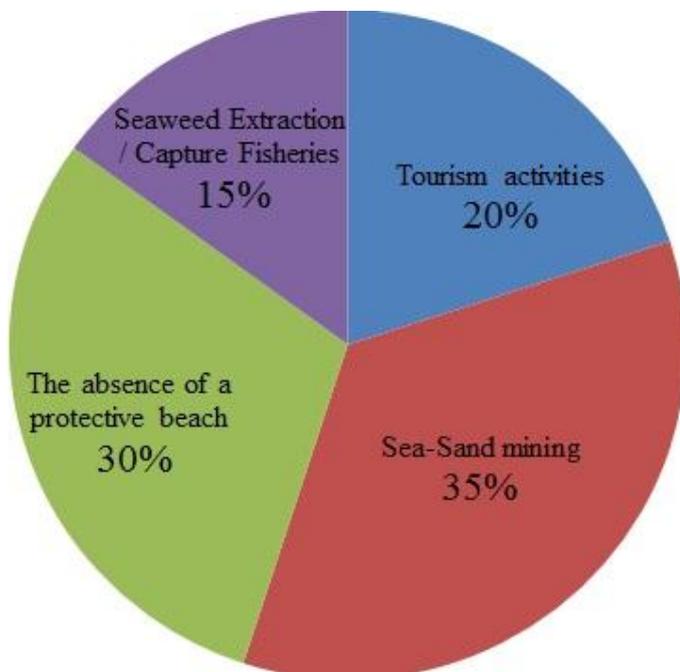


Figure 7. (a) Watersheds in Tuban Regency, (b) and (c) Budur Sub-Watershed which flow on Sowan Beach

Based on Figure 7, the Sowan beach is strongly influenced by the budur river flow. This condition shows that the class is "highly vulnerable"

### *Community Perception of the Causes of Erosion and Environment Damage to Sowan Beach*

The causes of erosion around the beach are based on community perceptions as shown in Figure 8



**Figure 8** Reasons for coastal erosion and environmental damage according to community perceptions

Figure 8 shows the causes of erosion and damage to the coastal environment from the point of view of the community around the Sowan Coast. According to analysing the results of questionnaires of 100 residents around the study area, one of the factors influencing the increase in coastal erosion intensity is the absence of coastal protectors, even though the community has informed that there is a need for coastal protection for local governments, but there is no right solution to reduce the situation.

Anthropogenic activities that cause erosion and damage to the coastal environment come from the activities of illegal sand miners. One-hundred (100) residents answered that illegal miners were not native Bogorejo people, but they came from some others village around Bogorejo, some even said they did not know where the illegal miners who accidentally took the sea sand around Sowan Beach,

Tourism activities are not a cause of coastal erosion, but are a cause of damage to the coastal environment. The development of infrastructure facilities is one of the factors that cause damage to the natural environment, such as the existence of a number of restaurants, guest houses, the use of boats to

develop tourism industry at Sowan Beach. Disposal of waste from restaurants and guesthouses is an important factor in damaging or degrading the environment. This is due to the absence of management or rules in garbage disposal. Waste that is directly discharged into the sea. Other problems are air and noise pollution activities such as marine charity, camp activities, festivals and garbage burning activities.

The activity of seaweed extraction and fishing is also one of the causes of Sowan's coastal damage. Some fishermen in fishing use fishing gear that is not environmentally friendly. In taking seaweed, fishermen usually enter the coral reef area, they can destroy the existing coral reefs

### **CONCLUSION**

Erosion and damage to the coastal environment have occurred on Sowan Beach which is one of the tourism areas in Tuban district. Based on the results of the scoring assesment of coastal susceptibility to human activities, it shows that the average Sowan coast is highly vulnerable, so a strategy is needed to reduce the level of vulnerability of the coast to human activities. Based on community perceptions, the main causes of erosion and environmental damage of Sowan Beach are caused by 4 activities, namely the absence of coastal protection, the presence of wild sand mining, tourism activities themselves and capture fisheries activities.

### **ACKNOWLEDGMENTS**

Special thanks to forestry service officials and the tourism agency of Tuban Regency who were stationed in the Sowan beach area for their support during the research as well as the community around the Sowan beach area so that this research went well

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