Hazard management in Parangtritis Beach tourism destination of Bantul District, special region of Yogyakarta

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Abstract. Parangtritis Beach is one of beaches in the southern part of Java, located in Bantul District, Special Region of Yogyakarta. The beach is located in the collision zone between the Indo-Australian Plate and the Eurasian Plate, and has mixed predominantly semidiurnal tides, inflicting potential hazards. This research was aimed to provide hazard management recommendation. The research had been conducted in March to April 2017. Data on potential physical and biological hazard were collected through observation, interview, and literature study. United Nation Environment Programme (UNEP) assessment was used as reference in analysing the data. Hazard-prone areas were mapped using ArcGIS 10.3 software. Physical hazard potentials found in the area were current, wave, earthquake, and tsunami. Jellyfish was the only biological hazard potentials found in the area. Current had the highest hazard risk level compared to other potential hazards identified in the area. Current emergence could be predicted through tidal conditions, wind, and weather. Stakeholder related to disaster management should be involved in preventive and repressive measures. Preventive measure included improvement of residents and tourists knowledge about types and location of hazard and disaster. Repressive measure consisted of the handling of hazard potential that cause the occurrence of accidents or natural disasters.

Keywords: accidents, hazard, management, natural disasters, Parangtritis Beach

1. Introduction

Parangtritis Beach is one of tourism destinations located in Bantul District, Yogyakarta Special Region. The beach, which is located in the southern part, has open sea scenery and limestone hill view to the North of the beach. Its physical and biological conditions have provide attractions for both domestic and foreign tourists, which lead to high visitations each year. Natural disaster or accidents may occur anytime, which threaten the safety of both surrounding community and visitors.

Records on several natural disaster and sea accidents in Parangtritis beach can be found, but the data on how the hazardous events occur is still lacking. Based on the data from the Search and Rescue (SAR) of Parangtritis beach, several sea accidents had caused casualties. Attention should also be given to tsunami and earthquake, which pose threat in the beach. Visitors’ safety and security are factors influencing visitors’ decision making and considered crucial in tourism activities.

Hazard management is an activity with certain objectives, implemented by tourism destination manager to reduce the risk of injuries, death, or loss of property rights, which may be inflicted on participants by known or estimated cause from both natural and man-induced hazards found in tourism.
destination [1]. The Tourism Agency of Bantul District in cooperation with Regional Disaster Management Agency have already made evacuation route and installed warning signs in the beach. However, sea accidents are still repeated each year, which required technical recommendation of hazard management for the manager of Parangtritis beach.

Therefore, identification of physical and biological conditions of Parangtritis Beach tourism destination and assessment of the identified hazard are needed. Identification may be carried out through field observation. This step would inform the management of the existence of hazard potential for surrounding community and visitors. Hence, hazard management recommendation for Parangtritis may be developed.

This study aimed to identify and assess both physical and biological hazard potentials in Parangtritis Beach, and to develop hazard management recommendation for tourism activities in the beach. The study was expected to provide data and information on hazard potentials, and reference and consideration in developing and implementing hazard management to ensure both community and visitors’ safety in Parangtritis Beach.

2. Method

2.1. Time and location
The study was carried out on March to April 2017. The location was Parangtritis Beach in Bantul District, Yogyakarta Special Region. The beach is geographically located on 110°20’47.29"-110°16’56.70" E and 8°0’39.35” – 8°3’45.70” S. A high number of both domestic and international visitors came to the locations since the beach is located adjacent to Parangkusumo Beach and Depok Beach. Parangtritis Beach is located on 30 km distance from Yogyakarta Municipality, and can be accessed by personal or public transportation in about 40 minutes.

2.2. Data collection
2.2.1. Instruments and tools. Interview guide was used as an instrument in this study. Other supporting tools included digital camera, voice recorder, Global Positioning System (GPS), and laptop equipped with ArcGIS 10.3, Google Earth, and MS. Office software.

2.2.2. Types of data and data collection method. Data collected included (1) tourism hazard management, (2) physical hazard potentials, (3) biological hazard potentials, (4) ecological conditions of the beach, and (5) community beliefs in relation to hazard’s risk prevention. Literature study, field observation, and interview were employed to obtain the data. Interview was carried out to parties involved in the hazard management of Parangtritis Beach, which included Tourism Agency of Bantul District, Regional Disaster Management Agency of Bantul District, and the search and rescue team (SAR team). Visitors and community were also interviewed. Visitors respondents were selected using the purposive sampling method, while the community respondents were selected using both purposive sampling and snowball sampling method. The additional snowball sampling method was used in order to obtain more accurate data on disaster information from those who have lived in the area for a long time and data on disaster occurrences. The number of respondents was 30 individuals for each community and visitors. The number of 30 samples represents the minimum acceptable sample size [2].

2.3. Data processing and analysis
Data was processed by assigning likelihood and severity, obtained from interview with the community and visitors, to each identified hazard potentials. A score was then assigned to each hazard’s likelihood and severity. The score of likelihood and severity referred to the UNEP assessment guideline [3]. The likelihood was classified into five level of likelihood, i.e. very often (score 5), often (score 4), quite (score 3), rather often (score 2), and rarely (score 1). Severity was also categorized into five level, very severe (score 5), severe (score 4), quite severe (score 3), rather severe (score 2), and
insignificant (score 1). The analysis started with assessing the risk of each potential hazard, which obtained by multiplying the likelihood and severity using the following equation:

\[ \text{Risk} = \text{likelihood} \times \text{severity} \]

The calculation provided a score of risk. The score were then categorized into three risk levels, i.e. substantial risk (score > 50), moderate risk (score of 16 – 50), and tolerable risk (score <16) [3]. Hazard’s risk reduction management was then determined based on risk level of each hazard potentials. There are four risk management options, which include accepting tolerable risk, avoiding risk, reducing risk, and transferring risk [3].

3. Result and discussion

3.1. Tourism potentials of Parangtritis Beach
Tourism activities offered in Parangtritis Beach included enjoying sunset and sunrise scenery, playing in the sandy area of the beach, swimming, fishing, and surfing. The waves, sand dunes, and beach scenery found in the beach had become the main attraction for visitors.

Tourism Agency of Bantul District had established specific arrangement in the form of group known as Kelompok Sadar Wisata (Pokdarwis) of Parangtritis Village for the surrounding residents who wish to provide direct contribution to the tourism activities in the destination. The residents lived in Mancingan Hamlet. Their livelihood included farmer, fishermen, craftsmen, and service sellers. The residents still carried out traditions and habits inherited from their ancestors, such as Bakti Pertiwi Pisungsung Jaladri ceremony to express their gratitude for the safety and abundant fortunes. The date of the ceremony was determined by the Yogyakarta Palace authority. The myth of Nyi Roro Kidul, known as the ‘ruler of South Beach’, was still alive and believed by the locals. Residents living near beach are usually a group of individuals who are relatively independent, have together lived in the area for quite a long time, and possess culture identical to the nature of beach [4]. Such characters were found in the residents living around Parangtritis Beach.

3.2. Characteristics of Parangtritis Beach

3.2.1. Climate and seasons. Parangtritis area had tropical rain forest climate with short dry season. The beach had an average annual rainfall of 203.7 mm per year and temperature of 25°C – 27°C. Both rainy and dry seasons influenced the geomorphology of the embankments of Parangtritis Beach. Rainy seasons were marked with the movement of sand materials, partially thrown towards the coast through the sweep of waves. Dry seasons were marked with the displacement of dried sand deposit along the beach, blew by the wind, forming sand dunes toward the land.

3.2.2. Oceanography. Parangtritis Beach had an open sea with beach horizon directly facing the Indian Ocean, forming a sloping beach [5]. Parangtritis Beach had average current velocity of 11.1 – 44.0 cm/s and the highest current occurs in December, dominantly toward Southwest direction, while the average height of wave reach 2.1 – 4.3 m [6]. December had the highest wave occurrences since the rainy season falls in October – April, which make December had high opportunity of the wave to reach its maximum point.

3.2.3. Ecological condition of the beach. Parangtritis Beach was characterized by sediment components in the form of blackish grey sand, which resulted from the debris of volcanic stones. The beach had straight shoreline and characterized by sand dunes in the beachfront. Parangtritis Beach had sand dunes ecosystem with plant species such as Ipomoea pescaprae, Pandanus sp., and Spinifex sp. [7]. Fauna found in Parangtritis Beach included squirrel (Callociurus sp.), sooty-headed bulbul (Pycnonotus aurigaster), large green pigeon (Treron capellei), swiftlet (Collocalia sp.), mangrove whistler (Pachycephala cinerea), white-bellied sea eagle (Haliaeetus leucogaster), Asian giant toad/river toad (Bufo asper), and several butterfly species. Marine biota found in Parangtritis Beach included jellyfish, antlion, and crab.
3.3. *Hazard potentials in Parangtritis Beach*

Physical and biological conditions of Parangtritis Beach in certain period might pose hazard potentials, which might disturb the visitors and the residents. Hazard potentials, identified from physical conditions, included current, wave, earthquake, and tsunami. Biological hazard potentials included jellyfish, which stings might have harmful effect for the visitors and residents.

3.3.1. *Beach current hazard potential.* The type of current with hazard potentials found in Parangtritis Beach was rip current and undercurrent. Rip current occurred 16 – 22 times a day in Parangtritis. Signals of its emergence could be visible when the sea level rises due to tides. In one day, the occurrence frequency of rip current increased during high tides and reached its peak on the highest tides [8].

Streams of current that continue to move below sea level due to the occurrence of the undercurrent caused the emergence of a trough area on Parangtritis Beach. The trough area is whirlpool with unpredictable mobile location. The signs of undercurrent emergence, which formed a trough, could be seen during high tides, where the water turned a darker blue.

Search and Rescue (SAR) Officer stated that the emergence of rip current and undercurrent had always caused sea accident. In comparison to other hazard potentials, sea accident occurrences were mostly caused by rip current and undercurrent. The currents dragged the victims farther to the sea and drowned them down the trough.

3.3.2. *Wave/upsurge hazard potentials.* Wave/upsurge of the sea, which had often caused accidents, was commonly resulted from two generator parameters, i.e. wind and the pulling force of the earth-moon-sun (tidal waves). Accidents occurred to the visitors, which caused by sea waves, were triggered by strong wind, and high tides that formed high upsurge [9]. Observation on 1 April 2017 showed that Parangtritis Beach had mixed predominantly semidiurnal tides type. Therefore, hazard potentials of wave/upsurge might be predicted to occur during high tide in the afternoon and the night (figure 1).

![Figure 1. Tidal elevation in Parangtritis Beach on 01 April 2017.](image)

3.3.3. *Earthquake.* Earthquakes are included in the occurrence of natural disasters that cause the earth's inner vibrations that occur as a result of the sudden release of energy accumulated in the deformed rocks. The source of energy being released can be resulted from plate collision, volcanic eruption, or rock/soil mass landslide [10]. Earthquake with Modified Mercalli Intensity (MMI) scale of I to III will release impact of vibration and ground motion, while earthquake with MMI scale above IV may cause tsunami [11]. Bantul District lies on collision zone of Indo-Australia plateau and Eurasia plateau with a speed of 7 cm/year [12].

3.3.4. *Tsunami hazard potentials.* Earthquake, which tremor can be felt up to the coastal area, had high possibility of causing tsunami [11]. Tsunami is a series of waves that travel very far in a long
period, usually caused by shocks associated with earthquake that occurred beneath or on the seafloor [13]. Up to 90% of deep-sea earthquake occurrences triggered tsunami [14]. The residents informed that the greatest tsunami with greatest earthquake impact was the one occurred in 2006.

3.3.5. Jellyfish hazard potentials. Biological hazard potentials that posed threat to visitors and residents found in Parangtritis Beach was jellyfish. This sea biota is categorized as hazardous biota due to its sting that may resulted in itchiness, fever, to deathly heart attack [15]. The SAR team of Parangtritis Beach informed that the jellyfish often found in the beach was plastic-like white bluish jellyfish, scientifically known as Physalia sp., which caused itchiness for those who stung by the species. Jellyfishes were often found at the beach, carried by the waves and wind during dry season. The number would increase in the middle of dry season. Dry season is always associated with high upsurge, strong wind, and current in coastal zone, which may increase the frequency of jellyfish emergence [16].

3.4. Risk of hazard potentials

Interview with visitors and residents resulted in information of hazard potentials that included rip current, waves/upsurge, earthquake, tsunami, and jellyfish. However, the number of respondents who were aware of the hazard potentials differed between visitors (figure 2) and residents (figure 3).

More visitors perceived waves/upsurge as hazard potentials due to high waves that they saw occurred in Parangtritis Beach, but less visitors perceived jellyfish as hazard potentials (figure 2). Meanwhile, the same number of residents perceived waves/upsurge as potentials hazard. More residents perceived rip current, earthquake, tsunami, and jellyfish as hazard compare to visitors. However, less residents perceived jellyfish as hazard compare to other potential hazards. Based on information obtained from both visitors and residents about the occurrences of incidents caused by each potential hazard, each potential hazard was then assigned the score of likelihood, ranging from 1 to 5, and severity, ranging from 1 to 8 (table 1). The risk was then calculated by multiplying the score of likelihood and severity, resulted in score ranging from 2 to 40, which fell into tolerable to substantial risk categories (table 1).
Table 1. Risk of physical and biological hazard potentials in Parangtritis Beach.

| No. | Hazard Potentials  | Score of Likelihood | Score of Severity | Score of Risk | Level of Risk   |
|-----|--------------------|---------------------|-------------------|---------------|----------------|
| 1   | Rip current        | 5                   | 8                 | 40            | substantial risk |
| 2   | Waves/upsurge      | 4                   | 8                 | 32            | substantial risk |
| 3   | Earthquake         | 4                   | 1                 | 4             | moderate risk   |
| 4   | Tsunami            | 1                   | 8                 | 8             | moderate risk   |
| 5   | Jellyfish          | 1                   | 2                 | 2             | tolerable risk  |

Rip current had the highest score of risk compared to the other hazard potentials. Though many visitors acknowledged the current as hazard potentials, many still lacked the knowledge of recognizing the signs of rip current emergence, while the rip might threat their safety at any time. Even the residents lived nearby were not necessarily knowledgeable of the signs of rip current emergence. Therefore, increasing both the visitors and residents awareness and understanding of the current was necessary.

3.5. Existing hazard management in Parangtritis Beach

Hazard management was aimed at reducing the risk of injury, casualty, or loss of property rights that might occurred to the residents and visitors. Hazard management in Parangtritis Beach involved Tourism Agency of Bantul District, Regional Disaster Management Agency of Bantul District, and SAR Community protection unit (Satlinmas) of Operational Region III.

3.5.1. The role of tourism agency of Bantul District. The Tourism Agency of Bantul District managed Parangtritis Beach tourism destination. The agency provided insurance for the residents and visitors who experienced sea accidents, which was included in the entrance ticket paid by the visitors in the Retribution Collection Place (known as TPR) of Parangtritis Beach. Insurance coverage for high-risk tourism activities was regulated in the Act No. 10 year 2009 on Tourism [17]. In addition, the agency, in collaboration with Kretek Police Sector, prepared and installed banners and warning boards along the road to Parangtritis Beach.

3.5.2. The role of Regional Disaster Management Agency (BPBD) of Bantul District. The Regional Disaster Management Agency (BPBD) of Bantul District was assigned by the government to manage disaster in the region. The agency was supported by other parties assigned to carry out disaster data collection and direct monitoring of disaster. Meteorology, Climate and Geophysics Agency (BMKG) provided daily data information on the potentials of hazard emergence. The data were obtained from the nearest observation station from Parangtritis Beach. The daily data used as reference of hazard potentials emergence included weather, wind, waves, and earthquake information. The information was then disseminated to the SAR team who used the information to adjust to the real condition in the field. Regulation of the Head of Regional Disaster Management Agency No. 3 year 2008 stated that BPBD has the duty to carry out disaster management, which include pre-disaster, emergency response, and post-disaster [18].

3.5.3. The role of Search and Rescue (SAR) Satlinmas of Operational Region III. Article 4 of the Government Regulation No, 36 year 2006 explains that the SAR has the duty to perform a continuous 24-hours standby to monitor the field for accidents/disasters occurrence potentials [19]. However, the study found that many of SAR officers in the field perceived that hazard potentials should be monitored more intensively only during high visitations, while during low visitations monitoring can be carried out from the SAR post. Hazard potentials may occurred anytime and threaten both visitors and residents [13], therefore 24-hours monitoring from the shelters provided would be necessary to cover the shoreline. SAR team of Satlinmas of Operational Region III assigned for direct monitoring in Parangtritis Beach had 48 members. The SAR collaborated with Water Police Directorate and
nearest Public Health Facilities in carrying out rescue. The SAR was equipped with facilities needed for monitoring and rescue, which included monitoring shelters, two-wheeled vehicles, loudspeakers, stretchers, ambulance, life vests and buoys, surfboards, rubber boats, first-aid boxes, swimming tires, red flags, warning boards, Handy Talky (HT), binoculars, police lines, incident boards, and report book of events.

3.6. Management of hazards’ risk reduction
Hazards’ risk reduction may be developed by classifying the hazard potentials based on its severity, frequency of occurrence, and risk level. For hazards with substantial risk, i.e. rip current and waves/upsurge, avoiding the risk might be the option of management (table 2). Moderate risks posed by earthquake should be reduce, while moderate risk posed by tsunami should be transferred (table 2). Accepting tolerable risk would be the option for tolerable risk posed by jellyfish (table 2).

| No. | Hazard Potentials | Severity | Likelihood | Level of Risk | Management Option |
|-----|-------------------|----------|------------|---------------|--------------------|
| 1   | Rip current       | High     | High       | Substantial risk | Avoiding risk      |
| 2   | Waves/upsurge    | High     | High       | Substantial risk | Avoiding risk      |
| 3   | Earthquake       | Low      | High       | Moderate risk   | Reducing risk      |
| 4   | Tsunami          | High     | Low        | Moderate risk   | Transferring risk  |
| 5   | Jellyfish        | Low      | Low        | tolerable risk  | Accepting tolerable risk |

Risk reduction management action for rip current hazard potentials may be taken through providing warning for visitors and residents who carrying out their activities on areas prone to rip current hazard. In addition, increasing both visitors and residents’ understanding of substantial risk of rip current, preventive action need to be taken, and how to avoid the hazard may also be necessary. Field observation showed that rip currents usually emerged on monitoring area in shelter 1 and shelter 2. Information obtained from the SAR team suggested that victims of undercurrent were also found in the same area (figure 4).
Risk reduction management action for waves/upsurge hazard potentials may be taken by preventing visitors or residents to carry out activities around the beach during high wave/upsurge. Field observation showed that high tides frequently occurred during 09.00 – 14.00 Western Indonesia Time, causing high waves/upsurge. Therefore, it is necessary to conduct more intensive monitoring towards visitors and residents activities in the beach and to provide warning for those who move nearing the seafront during high tide. Socialization activities to inform the visitors and residents of the time of high tide shall be carried out in order to put them on the alert.

Risk of earthquake hazard may be reduced by developing zonation on the nearest region to the beach with low risk of earthquake. The Regional Spatial Plan composed by the Regional Development Planning Agency (Bappeda) of Bantul District includes the coastal area of Parangtritis Beach into Earthquake Prone Area with very high hazard. The nearest region with low risk of earthquake is located to the East of Parangtritis Beach (figure 5). Therefore, the eastern region of Parangtritis Beach can be used as evacuation place in the course of earthquake.

Transferring risk may be carried out by involving local residents, in particular the SAR team, in training to deal with tsunami occurrence. In addition, the Tourism Agency as the manager of Parangtritis Beach may also transfer the risk of residents and visitors safety to the Regional Disaster Management Agency of Bantul District throughout tsunami occurrence.

Jellyfish had low severity and low frequency of occurrence. Though the risk of jellyfish can be accepted, the SAR team still need to do monitoring/supervision, particularly during high emergence of jellyfish (blooming of jellyfish).
3.7. Technical recommendation for hazard management in Parangtritis Beach tourism destination

Technical recommendations for hazard management proposed for Parangtritis Beach are adjusted to each identified hazard potentials. Both preventive and repressive actions are needed for each hazard potentials. Preventive and repressive actions referred to previous occurrences to minimize the risk of potentials hazard [20].

3.7.1. Preventive action. Preventive action is an action taken to prevent the occurrence of highest risk of any hazard potentials [13]. Preventive action for rip current is to provide warning for visitors and residents who carrying out their activities on areas prone to rip current hazard (figure 4). Activities should be carried out up to the coastline. Warning for visitors can also be done as preventive action for wave hazard. When the sea level rise and the tide is high, the visitors and residents may only do their activities up to the coastline. Red flags are important to provide alerts for the visitors and residents when the signals of hazard potentials emerge.

Development of early warning system is part of preventive action for earthquake hazard, while instalment of evacuation signboards on accessible locations may be an option for tsunami hazard preventive action. Preventive action for hazard from jellyfish may involve temporary closing of the beach during blooming of jellyfish.

Socialization of the potentials hazard for the visitors and the residents should also be included in preventive actions. The socialization aim to educate the residents and visitors about the signs of each hazards potentials emergence, areas prone to hazards, and locations safe from hazard and may be used.
as evacuation place. Dissemination of brochures in the Retribution Collection Place (TPR), instalment of interpretive boards of hazards consisted of map of hazards and the explanations, and extension program for the residents in the coastline villages of Parangtritis Beach add to the socialization activities.

Parties responsible for the hazard management of Parangtritis Beach tourism destination shall improve hazard management as preventive action. Improvements may include additional field officers assigned to record data of beach characteristics, such as tides, wind velocity, rip current emergence, trough monitoring, to enable identification of hazard emergence possibilities. BPBD of Bantul District shall collaborate with the BMKG and Geospatial Information Agency (BIG) to carry out daily recording of beach characteristics causing hazard potentials.

3.7.2. Repressive actions. Repressive action is an aid measure that has to be carried out using past occurrences as references in reducing the severity of hazard potentials [20]. Aid measures shall be carried out by the SAR officers, helped by the Water Police Directorate and nearest Public Health Facilities. Life vest is a minimum equipment shall be wear by a SAR officer during aid measures. The measures for victims of sea accidents caused by rip current and waves include seeing victim’s position, checking victim’s condition, and trying to calm down the victim. When the position of victim is far from the shoreline, aid equipment such as surfboard shall be used to speed up access to the victim and provide faster aid. When the victim is found unconscious, in water resuscitation shall be carried out [13].

During earthquake, aid measures that can be taken include directing the residents and visitors to the eastern part of Parangtritis Beach. SAR officer may ask assistance from Water Police Directorate to enable faster evacuation. Evacuation during earthquake should be done quickly since there is possibility of the earthquake to cause tsunami [20]. Aid measures during tsunami shall be more focused on the visitors who lacked the knowledge of locations safe from tsunami hazard. The residents are commonly have sufficient knowledge of the places safe and easily accessible in the course of tsunami from the evacuation signboards installed by the BPBD of Bantul District. Provision of first aid equipment is important in order to provide first aid for victims who are injured due to the panic.

Aid measures for victims of jellyfish stings include using warm water and cucumber. Warm water (40°C) sprayed on the body part stung by jellyfish can reduce initial symptoms such as burning and itchiness on the victims [15]. In addition, SAR officer suggested that smearing cucumber on the affected part has powerful effect to reduce the itchiness.

3.8. Conclusion
Rip current, waves/upsurge, earthquake, and tsunami were physical hazard potentials found in Parangtritis Beach, while jellyfish was the only biological hazard found in the beach. Both rip current and wave/upsurge posed substantial risk, with rip current having the highest score of risk, while earthquake and tsunami had moderate risk and jellyfish presented tolerable risk. The hazard management options suitable for the beach included avoiding risk, reducing risk, transferring risk and accepting tolerable risk, with both preventive and repressive actions for the implementation.

3.9. Recommendation
Improvement was needed to ensure visitors and residents safety in the course of accidents and disaster occurrences. Both preventive and repressive action shall be organized for each hazard potentials being identified. Past occurrences can provide reference to determine the most suitable course of action to take. Preventive action shall focus on education for the visitors and residents on subjects related to hazard potentials, while repressive actions shall focus more on appropriate handling of accidents/disaster occurrence. Further improvement on management and program planning may be needed to adjust to the dynamic conditions of the nature.
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