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POTENTIAL MULTI-DISASTER BASED ON LANDFORM CHARACTERISTIC IN PARANGTRITIS AREA

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Abstract

The assessment of potential disasters is a critical sectoral problem. Because hazard can damage and harm to people. The purpose of this research is to identify potential disasters in Parangtritis area. The identification based on the appraisal variables on some of the multi-hazards that may arise and threaten in this area based on the characteristics of the landform such as gisik, fluvio-marin plain, hills, alluvial plains, and others. This study includes exploratory and evaluation research with a qualitative approach. The results showed some potentially catastrophic hazards in the Parangtritis area, including tsunamis, abrasion, landslides, and floods. Each potential risk has a different level of insecurity and location distribution.

Keywords: Potential Disasters, Multi-Hazards, Qualitative, Parangtritis

A. Introduction

The assessment of potential disasters is a critical sectoral problem. Disaster studies are an essential aspect of an area's possible and challenge (Wahyuningtyas & Pratomo, 2015). Because of the potential disaster study is needed in the spatial planning of a region. Furthermore, the sustainable development Agenda emphasizes disaster risk reduction by minimizing the exposure and vulnerability of poor people to disasters (UNISDR, 2015). Climate disasters such as floods, storms, or landslides even have low intensity, but should not be ignored. This global experience of catastrophic impacts suggests that such events can destroy communities vulnerable to harmful effects. Also, disaster events pose additional problems that increase the cost of local public administration, emergency operations, and infrastructure recovery.

Excessive utilization of natural resources and uncontrolled land use triggered an increase in the impact of natural disasters resulting in the loss of human life and property damage. Many cities in developing countries have grown at high speeds in recent decades. Settlements have flourished everywhere in the disaster-prone hillside, flood plains even along the water body

(Marone, de Camargo, & Salcedo Castro, 2017; Ougougdal,2020) as much as 1.2 billion people globally live within 100 km of the coast, and sea-level changes most directly impact them.

Parangtritis is one of the coastal areas in the Bantul Regency, which is located in the southern part of Yogyakarta special region. The landscape of the Parangtritis region is largely influenced by marine and eolian processes making it an area with diverse landscapes. This diversity of land landscape makes the coastal areas of Parangtritis vulnerable to various natural disasters. Mukhopadhyay et al., (2016), states that coastal areas are often prone to natural hazards, especially areas with a population density and high infrastructure development. Hazards are potentially catastrophic, but not all hazards have always been a disaster, depending on their vulnerability and capacity. Areas with varying characteristics potentially also have different disasters. The multi-hazard concept is related to analyzing different relevant hazards (Gallina et al., 2016). Multi-Hazard refers to dangerous events that can cause a more significant impact than the number of single hazard effects (Terzi et al., 2019). Therefore, in the last decade, multi-risk assessments are increasingly attracting researchers, particularly the risk assessments derived from various natural and human-made dangerous events (Farrokh and Zhongqiang, 2013; Gallina et al., 2015).

Previous studies on multi-risk done by van Hoof et al., (2020), made the framework steps for a multi-risk assessment in the sea consisting of exploring, understanding, assessing, deciding, implementing, and evaluating communications. Mukhopadhyay (2016), conducts multi-criterion analysis for six hazards, namely coastal erosion, hurricane waves, sea-level rise, coastal floods, tsunamis, and earthquakes in India. Coastal erosion and storm wave puddles are two of the natural hazards that are most threatening and affecting the coast. The multi-hazard risk assessment aims to connect risk reduction activities using a probabilistic approach. The probabilistic approach is to get the appropriate set of events for estimated losses and create risk outcomes in different metrics after collecting loss data from different hazards (Bernal et al., 2017). The underlying components that should be considered in a multi-risk assessment are the danger, element risk, and vulnerability. Danger refers to physical phenomena that potentially damage human and natural systems (Gallina et al., 2015).

In this paper, we consider the assessment of various forms of land in the coastal areas of Parangtritis as a case study. This paper aims to describe various disasters that may occur in this region based on the landform. It is possible to identify the variables for each multi-risk component and its interactions, such as floods that trigger erosion and landslides (Tarzi, 2019). The concept of multi-Hazard aims to help decision-makers for the Government to manage limited resources (Horigan et al., 2018). This study's results as a disaster mitigation effort could be used for optimal management by decision-makers for land use planning by avoiding danger-prone locations.

B. Methodology

1. Research Design

The study uses exploratory and evaluative research methods using a qualitative approach. This type of exploratory research aims to discover something new that can be a grouping of specific symptoms, facts, and diseases. Meanwhile, evaluative research has two main activities: measuring or retrieving data and comparing the measurement and data collection results to the standard used (Wahyuningtyasa and Pratomo, 2015). The data collected is obtained directly through field surveys and secondary data obtained from reference data related to the study. Secondary data obtained from literature studies and related agencies. Literature study by searching through books, journals, previous research results, and websites. Agency data from Regional Disaster Management Agencies.

Our study focuses on the coastal area of Bantul in Special Region Yogyakarta, which includes the three sub-districts of Srandakan, Sanden, and Kretek. Bantul Coast has a tourist attraction of Parangtritis beach. The southern part is a beach consisting of loose gravel-sized materials. It has 5 five rivers: Oya, Opak, Progo, Winongo, and Code. Also, it has a hill with a slightly steep slope low hills with a slope-steep. (BPS, 2020). This area has been used as a tourism area, causing changes in land use where infrastructure built to support tourism activities. Besides, increasing population leads to increased settlement needs. They built settlements that must be safe and avoid areas vulnerable to disasters (Fig. 1).

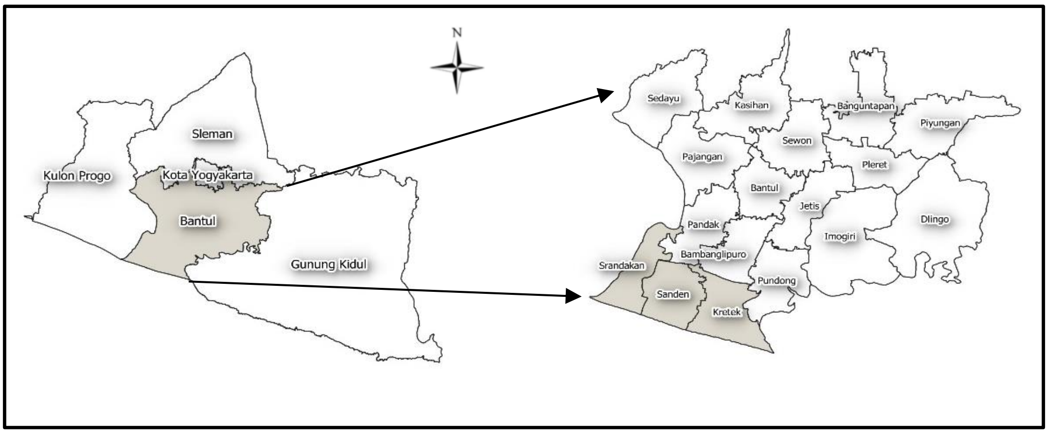

Fig. 1. Location of the study in Bantul, Special Region Yogyakarta, Indonesia.

2. Instruments

The instrumens used in this research

a. Digital Camera
b. A Personal Computer
c. Software like Microsoft Office, Google Earth, QGIS 3.10, and ArcGIS 10.2
d. Global Positioning System (GPS)

3. *Technique of Data Analysis*

Data is analyzed spatial to find potential disasters based on the form of land observed. It is using the Explorative method, which connects the variable with the other variable. Spatial data that analyze with descriptive methods described explorative. Analysis of exploratory description used for the results of a more in-depth study by linking one variable with others (Saputro et all., 2017)

C. Findings and Discussion

1. Findings

Coastal areas are dynamic between land and sea and very complex areas (Michael et all., 2017). The pressures of various activities both by humans and nature like sea tides, erosion, flooding, settlement construction, and forest-building have impacted the coastal ecosystem. To find out the impact, we investigate the various landform in Parangtritis. Parangtritis has an variety of interesting of land forms including beaches, hills, rivers, floodplains, and sand dunes which cannot be found in other areas in Indonesia (Pramono, 2007) . From the observations made in the field obtained results, as presented in Table 1.

2. Discussion

a. Tsunami

Indonesia is at the gathering of three tectonic plates so that earthquakes are prone. Earthquakes that occur can result in dislocations or changes in the seabed. This sudden dislocation will cause a new surface elevation change, so it forms a wave that will spread in all directions called Tsunami.

Table 1. Potential multi-disaster in the region of Parangritis like tsunami, abrasion, avalanche, and flood

No	Landform	Type of hazard	Element at risk	Erosion	Land Use
1	Gisik/beach	Tsunami, Abrasion	Coastline	Yes	Fishery and tourism
2	Summer berm	Tsunami	Food stall	Yes	Tourism
3	Backswamps	Flood	Human and Farmland	Nothing	Agriculture
4	Fluvio-Marin	Flood	Human and Settlement	Yes	Agriculture
5	Foothills	Landslides	Human and Settlement	Yes	Settlement, and Agriculture
6	Hillside	Landslides	Human, Settlement, and Public infrastructures	Yes	Urban
7	River	Flood	Farmland	Yes	Agriculture
8	Alluvial Plain	Flood	Settlement	Nothing	Settlement, and Agriculture

Source: field observations, 2019.

Based on observations and relevant literature studies, the Parangtritis coast is vulnerable to tsunami disasters. The tsunami could potentially hit the south coast of Java, including Parangtritis, where the primary cause is plate subduction between Indo-Australians and Eurasian plates, 2006 tsunami once occurred in this region (Susmayadi et all., 2014). This disaster has the "Ring of Fire" in the Pacific Ocean as its epicenter, the presence of high energy, and the flow of water crashing into the adjacent land (Teresa, Vasanth, & Vidya, 2020)).

The Indo-Australian plate moves to the north by showing the Eurasian continental plate at a speed of ± 7cm/year. Further, it includes one of the eight seismic gaps (seismic gap) that potentially experience earthquakes with large magnitude(Marfai, Cahyadi, & Anggraini, 2013). The existence of hydrodynamic in the Parangtritis coast caused the area to be potentially catastrophic such as tsunamis, rip currents, abrasions, and the reflection of waves (Marfai et al., 2013).

The tsunami waves hit the coast and flooded the water to the lowland coastal areas with such high power that can cause severe damage, as moving objects can be potentially dangerous when moving out of control. As the tsunami ensued, the waves were long, traveling at high speed across the waters to the mainland, crashing into the coast and flooded several miles inland (A. Rose Enid Teresa, 2020). Thus, it causes casualties and damage infrastructure, such as commercial, residential buildings, ports, and industrial areas of the coastal zone. Erosion also causes tidal bathymetry changes due to sedimentary and erosion deposition (Kuriyama et al., 2020). (Teresa et al., 2020) categorizes the effect of the tsunami into direct and indirect effects. Direct effects ask the impact of waves on structures and archaeological sites. Indirect effects ask following the event, like the autumn of the economy, disruption in transportation, and telecommunication. Parangtritis is increasingly vulnerable because it includes part of the Special Economic Area.

b. Abrasion

The abrasion or erosion of the coast lately tends to extend in several regions. Abrasion is that the erosion or reduction of land thanks to wave, current, and tidal activity. It is resulting from rising sea level on sandy beaches or mud beaches may result in the change of coastline, both shifting the shore and landline. Another impact of coastal erosion is the impact of social effects on people's lives and social structures, such as changes in livelihoods (Marfai et al., 2013). Changes in coastal configurations are influenced by land and sea processes due to both natural and human activities. The marine process affects the tide, the wave, and the tidal pattern changes—the process of land, among others, erosion and sedimentation from streams.

The typology of the Parangtritis area influence by the geological history of the Gunungsewu Karst area formation, which is part of the southern plateau of Java Island, which experienced the Rapture (Haryono, Adjie, & Suratman, 2011). The beach typology in Parangtritis consists of three kinds are muddy sand, sandy beaches, and rocky beaches. The appearance of Parangtritis Beach is shown in Figure 1. Saputro, et al, (2017), the typology of sandy beaches has the highest susceptibility to abrasion because it has degradable materials. Open beach conditions produce more significant waves and currents. The incline Relief of sandy beaches in the typology is increasingly triggering vulnerability to coastline change. This condition causes the coastal area of Parangtritis to have a high risk of coastal abrasion. The hazard that occurs in the coastal regions of Bantul in Yogyakarta is the change of coastline that is influenced by abrasion (Saputro, 2017). Abrasion worsens the beaches' ability to prevent or reduce disasters by eliminating wave energy because abrasion threatens breakwaters' stability (Kuriyama et al., 2020).

(a) (b)

Figure 1. Sand-framed beach in the Parangtritis area, 2019. A) Gisik with a steep slope and large waves showing high abrasion processes. b) Summer beach as a place where fishers ship as a tourist area.
(Source: Field observations, 2019)

c. Landslides

Landslides are a prevalent geomorphic danger with considerable economic and ecological consequences, and it causes damage and death and injury every year (Chen et al., 2015). Landslides have caused massive casualties and substantial economic losses in the world's mountainous regions (Pourghasemi, Pradhan, & Gokceoglu, 2012). Landslides show the erosive process of geomorphological origin, which actively threatens coastal areas (Ayt Ougougdal et al., 2020).

Even though the damage to the landslides is relatively small compared to earthquakes, but higher incidence rate frequency makes it very important to manage disaster risk, as it can be an essential accumulation of losses from time (Bernal, 2017). Therefore, the vulnerability of landslides is crucial for development planning and mitigation (Posner & Georgakakos, 2015). Landslide and vulnerable inventory is a hazard mitigation effort to reduce the impact of the landslide (Pourghasemi, 2012).

Analysis of landslide hazards can be batter into two main components: (1) the vulnerability of landslides; and (2) trigger factors. The first, disaster risk in the research area is associated with topographical conditions, including steep so that the probability for landslides becomes high. Saputro (2017) This area has a steep hillside with a steep slope dominant more than 70%. Landslides can occur in hilly or mountainous landscapes, and the increasing slope is most likely that mudslides are growing (Posner, 2015). The degree of inclination is the primary parameter associated with landslides (Chen, 2015). The cliffs undergo various erosional processes with landslides as the most significant mode of the recession (Ougougdal, 2020).

The second component, the morphological and rainfall structure, affects landslides' tendency (Pourghasemi et al. 2012). High-intensity rainfall triggers the incidence of landslides (Posner, 2015; Ougougdal, 2020). At the site of research, there is erosion, where the erosion is closely related to rain. This indicates that the hilly area of Parangtritis is vulnerable to landslides. Mountainous areas are highly vulnerable to climate impacts, including changes in the water cycle, biodiversity loss and ecosystem services, and human safety (Terzi, 2019). The hills of Parangtritis are shown in Figure 2.

Elements at risk of being exposed disaster both humans and facilities are quite large because the slope used as a plantation and the foot of the hill is for settlements, as shown in Figure 2. Land use and vegetation cover play an essential role in the stability of the slope (Pourghasemi et al. 2012). Human activity has a vital role in the occurrence of slope instability. Further, Bernal (2017), vulnerability to landslides corresponds to a subjective probability of occurrence of landslides in specific locations, depending on the nature and anthropogenic characteristics of the slopes. Therefore, the use of hilly land in Parangtritis, such as settlements and plantations, is less supportive of maintaining the slope's stability.

(a) (b)

Figure 2. Conditions hill in Kretek, Parangtritis, 2019. a) Erosion damage due to the flow of rainwater b) Foot slope, which uses as a place of settlement very range of landslide hazards. (Source: Field observations, 2019)

d. Flood

Table 1 shows that landform with potential flooding occurs among back swamps, fluvial-marine, estuary, and alluvial plain. Flooding is one of the most hazardous around the world. Flooding causes by some factors that interact (Johnson et al., 2016). Furthermore, the imbalance between the natural and human environment causes a higher risk of flooding (Duy, Chapman, Tight, Linh, & Thuong, 2018). Flooding can occur due to natural factors such as high rainfall, the location of the flood is on a relatively flat topography on a meandering, flood plains with a slow soil structure that permeated water, and rivers that can not accommodate and drain water into the sea. Annual rainfall because it can affect the change in water catchment so that it is relevant to flood disasters (Johnson, 2016).

Human factors also contribute to flooding, including the increasing population that occupies the river and natural flood plains to reduce water bags and loss of catchment areas due to the change of land function for various purposes (Wahyunigtyas & Pratomo, 2015). Increased human activity at Parangtritis increases vulnerability to the flooding risk, especially in areas related to watersheds such as alluvial plains and rear marshes. Also, an increase in the number of housing areas vulnerable to flooding will impede sustainable regional development. The combination of compact space with increased endurance is an approach to reducing the risk of flooding. Therefore, a more presentable strategy for planning and spatial management is needed to minimize flood-prone areas (Duy et al., 2018). Reduce the risk of flooding through preventive strategies (e.g., spatial arrangement), preparedness (e.g., emergency management), and Recovery (Mees et all., 2018). River and the plain alluvial shown in Figure 3.

(a) (b)

Figure 3. River and alluvial Plain in Srandakan sub-district, 2019. a) The river banks are used farmland. b) Alluvial plain used as agricultural land because it has fertile soil.
(Source: Field observations, 2019)

D. Conclusion

Every form of land has disaster potential. Some of the potential disasters in the Parangtritis area are tsunami, abrasion, avalanche, and flood. From some of these disasters, development is also a factor that contributes to the impetus of disaster. In the development process, the vulnerability could not avoid. Therefore, the settings on the critical aspects that affect the vulnerability need to make and applied to keep the compensation sustainable. Each region and population is continually changing. Disaster risk reduction should anticipate the consequences of region dynamics, especially this area, for the risk of multi-hazards in the future.

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