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THE FLOODING CAUSES ON THE NORTH COAST OF JAVA

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Abstract

The floods and tidal handing that have been carried out on the north coast (Pantura) of Java are still partial. It is necessary to study the factors that cause coastal floods on the north coast (Pantura) of Java and their impacts that can be used as a parameter in flood handling strategies. Qualitative methods were used in this study using diverse data collection. Based on the analysis, the factors causing floods on the north coast (Pantura) of Java are changes in land use, rainfall, and land subsidence, the influence of high tides, improper flood control, and slums. Meanwhile, the flood handling that has been carried out by the related institutions is by making embankments and parapets in Pekalongan Regency, building seawalls, erecting sheet piles, making pumps and pump houses in Pekalongan, land acquisition of 10,500 m^3 by Pekalongan City Government.

Keywords: Flood, Coastal, North Java, Pantura

INTRODUCTION

Indonesia is a country with a large coastal area, the problem of flooding is a separate threat to coastal areas, including the north coast (Pantura) of Java which is flooded due to inaccuracies in land use and increased residential areas [1]. Flood is a natural phenomenon that occurs due to high rainfall intensity which causes inundation in an area [2]. Floods on the north coast (Pantura) of Java are caused by rain and high tides which cause negative impacts, especially on the economic sector, paralysis of activities, and losses in coastal areas [3]. Pantura coastal areas that are seriously affected by floods due to the intensity of rain and high tide are the cities and regencies of Demak, Semarang, Pekalongan, Pekalongan City, and Tegal City [4]. The worst history of coastal flooding occurred in February 2021 on the coast of Pekalongan Regency, due to the high intensity of rain (>50 mm / day) and tides reaching 0.9-1.1 m [5].

The handling of floods and tidal coastal areas that have been implemented is still partial and land subsidence every year is quite high so inundation areas are expanding and the length of time inundated is getting longer. The handling and management of coastal floods in Pantura have been carried out structurally and non-structurally. Structural handling has been carried out on the north coast (Pantura) of Java, one of which is handling floods in Semarang and Pekalongan by normalizing rivers, handling rivers with corrugated concrete sheet piles, rehabilitation of floodgates, construction of pump houses and construction of embankments, but the handling is considered not optimal [6].

It is necessary to study the factors that cause coastal floods on the north coast (Pantura) of Java and their impacts that can be used as a parameter in flood management strategies.

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METHOD

This study aims to determine the factors causing floods and their impacts on the Pantura coast. Qualitative methods were used in this study, with a descriptive qualitative approach using diverse data collection.

The approach used in this study is a qualitative approach with a qualitative descriptive method, by finding facts by studying a problem, relationship, attitude, activity, or view contained in society or a process and influence in a phenomenon [23]. A qualitative approach with multiple data collection (multiple sources of information). The stages of analysis carried out are as follows:

1. Analysis of the factors causing coastal Pantura flooding was carried out with the study of other supporting theories.
2. Validating the results of the analysis, it is necessary to see the suitability between the factors that cause coastal flooding based on the literature review of the phenomenon.

RESULTS AND ANALYSIS

a) Coastal Area

The coastal areas are the boundaries of coastal areas where land borders the sea, the boundary towards land includes land areas that are still affected by tides, sea breezes, and seawater intrusion [7]. A coastal area is a place where rivers are emptied, the area is flood-prone because the area is a lowland whose ground level is lower or equal to the average tide level [8]. The coastal area problems are caused by double utilization, unbalanced utilization, and the influence of human activities [9]. Most residences in coastal areas have characteristics such as poor drainage, damaged roads, river sedimentation, improper sanitation facilities, and inadequate hygiene quality [10].

Table 1: Pantura Coastal Characteristics

No	Pantura coastal area	Characteristics of coastal areas
1.	Coastal District of Rembang	Rural coastal area
2.	Coastal District of Pati	Rural coastal area
3.	Coastal District of Demak	Slum coastal area Rural coastal area
4.	Coastal City of Semarang	Coastal residential areas are densely constructed Flooded coastal area
5.	Coastal City of Pekalongan	Coastal areas inundated areas Slum coastal area
7.	Coastal District of Pekalongan	Coastal areas inundated areas Slum coastal area
8.	Coastal District of Pemalang	Rural coastal area
9.	Coastal City of Tegal	Coastal areas inundated areas Slum coastal areas Coastal areas are densely constructed

The characteristics of coastal areas are classified into slum residential areas (coastal, coastal on the edge of the city, coastal city) characteristics: located on the urban coast, dense housing,

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exposure to tidal inundation, slum housing, poor environmental conditions, poor facilities, and infrastructure; densely built coastal residential areas have the following characteristics: high density, the predominance of buildings is permanent, the yard is narrow, the front of the house is on the side of the road, the facilities and infrastructure are not good [11]; the coastal area of the flood inundation area has the characteristics of inundation when it rains, plots of medium and large residential areas; and rural coastal areas are characterized by the linear distribution of settlements, low density, lots of land, not too tightly spaced buildings, generally single-story houses [12]. Based on the characteristics of the coastal area above, the condition of the coastal area of the north coast (Pantura) of Java can be seen in Table 1.

b) Coastal Flooding

Flood is a natural phenomenon that occurs due to high rainfall intensity, it causes excess water that is not accommodated by the severance network in an area which has an impact on the emergence of inundation and can be detrimental to the community [13]. Flooding is a condition where water cannot be accommodated in the drainage canal, so it overflows into the surrounding flood area [14]. Floods that occur on the coast of Pantura are caused by rainwater, faulty river channel construction, siltation, and sea level rise [15]. Floods are divided into several types, rainwater flooding caused by high rainfall and lack of land absorption, tidal flooding which is a phenomenon of seawater entering the mainland during high tide and intrusion of seawater through rivers and drainage [16], river overflow floods, coastal floods and flash floods [17].

c) Factors causing coastal flooding

Floods are caused by natural factors (rainfall, river capacity, influence of tides, subsidence, tidal) and human factors (changes in land use, waste, sedimentation, slum areas, inadequate river capacity, and damage to flood control buildings) [18]. According to Pamungkas, the problem of Pantura coastal flooding is caused by inappropriate flood control, changes in flood characteristics, use of riverbanks, excess groundwater extraction, and improper handling of flood problems [19]. Other causes of coastal flooding are sea tides, land subsidence, and changes in spatial use [20]. Factors causing coastal flooding are caused by changes in land use, waste, erosion, and sedimentation, slum areas, inappropriate flood control system planning, rainfall, physiographic influences, river capacity and inadequate drainage capacity, the influence of tides, damage to flood control buildings [21]. Other factors causing coastal flooding are caused by rainfall, watershed characteristics, changes in land use, and river management [22].

The factors that cause flooding on the northern coast of Java are caused by many factors, but in the research conducted, all of these factors cause flooding in the northern coastal areas such as river conditions, land changes, climate, rainfall, poor planning inappropriate, inappropriate flood control, the influence of tidal water, damage to flood control buildings, slum areas, inappropriate flood management, excessive use of underground water, and land subsidence and tidal.

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d) Land use change

The increasing human activity will increase the need for space to support social activities. The development of the Pantura coastal area as a strategic area has made it the center of economic activity [24]. This has an impact on the condition of land cover in the coastal area of the north coast. Data on changes in the land area of the regency and coastal city of Semarang can be seen in table 2 [25]. The use of land on the north coast is dominated by building areas for companies, industry, and services, while the land is vacant land and rice fields have decreased.

Table 2: Area Usage of Semarang City 2017-2019

No	District/City	Land use area (Ha)		
		2017	2018	2019
1.	Rice field	3,789.63	3,789.63	3,791.30
2.	Garden	7,588.71	7,588.71	7,638.70
3.	Planted trees	1,344.92	1,344.92	1,418.60
4.	Pond	4,633.84	4,633.84	-
5.	Roads/ settlements/ offices/ rivers, etc.	17,768.2	17,768.2	17,993.3

Source: BPS in numbers, 2019

From Table 2 it can be concluded that land use in the coastal city of Semarang is dominated by building land in the form of roads, settlements, office buildings, and other infrastructure that affect coastal flooding.

e) Rainfall

In the 2019-2021 period, the largest rainfall in the coastal area of Pekalongan city occurred in 2021, especially in February. Rainfall in the Pekalongan city area fluctuates from year to year depending on meteorological and climatological conditions, the largest annual rainfall is in 2021 with 3,303.00 mm/year. Rainfall data in the coastal area of Pekalongan city can be seen in table 3 [26].

Table 3: Semarang Rainfall Data 2019-2021

No	Month	The Amount of Rainfall (mm)		
		2019	2020	2021
1.	January	749.00	497.00	371.00
2.	February	313.00	763.00	1309.00
3.	March	251.00	351.00	269.00
4.	April	163.00	203.00	141.00
5.	May	97.00	252.00	143.00
6.	June	16.00	20.00	147.00
7.	July	82.00	15.00	61.00
8.	August	0.00	76.00	170.00
9.	September	0.00	135.00	166.00
10.	October	69.00	76.00	43.00
11.	November	36.00	196.00	263.00
12.	December	55.00	312.00	220.00

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f) Land subsidence

Land subsidence can be interpreted as a decrease in the elevation of the ground surface to a reference plane that is considered stable. Factors causing land subsidence are excess water withdrawal, geological cycles, volcanic-tectonic activity, and heavy loads on the ground such as building structures. Soil subsidence is one of the factors causing flooding in coastal areas, for example, the highest land subsidence in 2021 occurred in Sayung, Demak regency with a decrease rate of 15 cm per year while the lowest in Tanah Mas with 7 cm per year. The following is data on subsidence on the coastal land subsidence in Semarang and Demak in 2021 [27].

g) Influence of the tide

Sea tides arise due to the Earth's gravitational pull on the moon and sun, tides are divided into three types, diurnal tides, semidiurnal tides, and mixed tides. Floods that occur in the coastal areas of the north coast (Pantura) of Java are caused by the influence of tides, especially areas with relatively sloping areas. The following is sea level height data at the highest tide conditions on the coast of Pekalongan city in 2021 [28].

Table 4: Usage Area of Semarang City 2015-2018

Sea Wave Height (M)	Height(M)		
	Coastal Sea Level	Tide Period	Accumulation
0.71	0.11	0.406	0.516
1.93	0.30	0.406	0.706
4.61	0.66	0.406	1,066

Due to the influence of coastal tides in the city of Pekalongan, several residential areas will be affected by flooding in 2022. Flood conditions due to tides can be seen in Figure 1.

Figure 1: Flooding due to tides in the coastal city of Pekalongan

h) Improper Flood Handling

One of the tidal flood handlings that have been carried out on the coast of Pekalongan by Presidential Regulation No. 79 of 2019 is flood control in the Loji river system and flood control in the Sengkarang river system, but flood handlings are considered less than optimal. In the 2020-2024 RPJMN the target is disaster risk reduction in 20 provinces with high disaster risk, regarding the target the coastal area of Pekalongan and Semarang is a priority. In this goal,

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several strategies are needed, including increasing cooperation between relevant stakeholders, outreach to the public regarding flood management, cooperation in increasing human resources with academics, and intensive coordination with the central government to achieve Presidential Regulation No.79 of 2019.

i) Slum Area

In Law Number 1 of 2011 slum residential areas are uninhabitable due to the irregularity of building, the level of density, the quality of facilities, and infrastructure that do not meet the requirements. One of the causes of coastal flooding is the condition of coastal slum areas which are dominated by residences without legality. Physical indicators of coastal slum conditions are accessibility conditions, building conditions, facilities, and infrastructure conditions while non-physically are population, socioeconomic conditions, and legality.

Figure 2: The condition of the slum coastal area of Loji River (Pekalongan)

j) Flood Handling

Flood handling that has been carried out by related institutions in reducing Pantura floods includes: making embankments and parapets in Pekalongan Regency (2019), construction of coastal seawalls in Pekalongan City (2017), sheet pile erection on the coast of Semarang City (2019), construction of pumps and pump houses in Pekalongan (2019), acquisition of 10,500 m^3 of land by Pekalongan government (2019). While the coastal flood control plans that have been made by related institutions include: the design of a 5,000 m^2 retention pond in Pekalongan, the construction of a weir, parapet with corrugated concrete sheet pile 700 m downstream, and 500 m downstream in Pekalongan Regency, mooring pond design for 204 ships.

CONCLUSION

Based on the description of the factors that cause flooding on the north coast (Pantura) of Java, several factors that cause flooding are changes in land use, rainfall, and land subsidence, the influence of tides, improper flood control, and slum areas. Meanwhile, flood control has been carried out by related institutions such as making embankments and parapets in Pekalongan (2019), construction of the coastal seawall of Pekalongan City (2017), erection of Sheet piles on the coast of Semarang City (2019), making of pumps and pump houses in Pekalongan (2019), land acquisition of 10,500 m^3 by the Pekalongan city government (2019). While the

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coastal flood control plans that have been made by the relevant institutions include: the design of a 5,000 m^2 retention pond in Pekalongan, the construction of a mobile weir, parapet with corrugated concrete sheet pile 700 m downstream and 500 m downstream in Pekalongan regency, the design of the mooring pool for 204 ships.

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