Spatial Modeling of Tidal Flood Hazard and Mitigation Efforts in the Coastal Area of Bandar Lampung City, Indonesia

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Abstract
Tidal flooding represents a natural phenomenon that presents a significant risk to coastal regions in Indonesia. It occurs when sea tides inundate an area with a topography that is below sea level, such as Bandar Lampung City's coastal areas. In order to mitigate the adverse effects of tidal floods in these regions, it is essential to develop a comprehensive model of the tidal flood hazard, coupled with effective mitigation strategies. In order to evaluate the potential for tidal flooding, inundation modelling was conducted using the minimum height of tidal flooding (10 cm), the value of the low tide level (43 cm), and the highest tide during full moon conditions (160 cm) with the Digital Elevation Model (DEM). The ArcGIS software was employed to create a model of inundation through the use of the raster calculator tool, resulting in the generation of a map that delineates the extent of tidal flood hazard levels and the areas that would be affected. The modeling analysis indicates that the tidal flood hazard affects an area of 172.95 hectares. The land uses most susceptible to impact are shrubs and settlements. Panjang Sub-district experienced the most extensive inundation area due to its residential, industrial, trade, and port activities in the 160 cm inundation scenario. In order to mitigate the risk of tidal flooding, various measures can be implemented, such as raising house floors, constructing multi-storey houses, implementing residential conservation, and developing mitigation plans through spatial planning and control strategies. The level of tidal flood hazard, existing adaptation and mitigation measures, and characteristics of tidal flooding can be used as a reference in the formulation of coastal management strategies to mitigate the impact of tidal flooding in coastal regions.

Keywords: Bandar Lampung, Disaster Mitigation, Indonesia, Spatial Modeling, Tidal Flood Hazard

1. Introduction

The coastal environment is a complex and dynamic land-use environment [1] and [2]. Indonesia's coastal areas exhibit considerable potential in a number of key areas, including biological resources, energy and minerals, maritime and industrial services, marine transportation and environmental services, as well as cultural resources [3] and [4]. The conditions and events that happen along coastlines are directly connected to the risks of natural disasters occurring in those areas [5] and [6]. Indonesia is particularly vulnerable to coastal disasters, including tidal flooding, which is a common occurrence in coastal areas.

Tidal floods present a significant threat to areas with a topography that is lower than sea level [7] [8] [9] and [10]. It is crucial to acknowledge that tidal flooding can be precipitated not only by high rainfall intensity but also by climate change. An increase in temperature resulting from climate change will lead to a faster rise in sea levels [11]. Rising sea levels and frequent storms can cause flooding that puts people living near the coast in danger. Indonesia is considered to be particularly susceptible to the impacts of climate change [12].

The impact of climate change are evident in a multitude of regions across the globe, including Bandar Lampung City, which has been identified as meeting three criteria indicative of a high risk of climate change impacts [13]. This is corroborated by the characteristics of Bandar Lampung City, which is situated in a coastal area with a relatively high population density [14]. Analyses of macroclimate data have indicated the presence of climate change in Bandar Lampung City over the past 23 years [15]. This is evidenced by the observed alterations in both the minimum and maximum temperatures throughout the year, which have led to an increase in sea level and a rise in tidal flooding in coastal regions. Therefore, tidal flooding in Bandar Lampung City occurs on an annual basis [16].

Rising sea levels could make coastal flooding worse in the coming years. This is a critical concern for island and coastal nations around the globe [17]. As an archipelagic nation with the world's second-longest coastline, Indonesia has identified coastal management as a national development priority. This encompasses the formulation of comprehensive and integrated policies that take into account the diverse characteristics, potentialities, and challenges that are present [18]. The incorporation of sea level rise-induced tidal flooding considerations is fundamentally imperative in coastal management strategies, as this natural phenomenon significantly influences coastal dynamics and vulnerability [5] and [19]. The identification of tidal flood hazards is of paramount importance for the implementation of integrated coastal management strategies that facilitate sustainable regional development [20] and [21]. One of the initial steps in the development of a coastal management plan is the undertaking of tidal flood inundation modeling analysis [22]. The aim of this study is to identify the distribution of tidal flood hazards across the city of Bandar Lampung and to examine the measures taken to mitigate these hazards. The findings of this study may provide novel insights into the evaluation, identification, and prioritization of adaptation and mitigation strategies in coastal areas, particularly at the local level.

2. Methodology

2.1 Research Location

The research was conducted in the coastal area of Bandar Lampung City, which serves as the capital of Lampung Province. The city has an area of 197.22 km² and is subdivided into 20 administrative districts, comprising 126 villages. The city is situated at an altitude ranging from 0 to 700 meters above sea level, exhibiting a diverse topography that encompasses coastal areas, hills, and highlands. There are four subdistricts of Bandar Lampung City that are in close proximity to the waters of Lampung Bay are Teluk Betung Timur, Teluk Betung Selatan, Bumi Waras and Panjang (Figure 1).

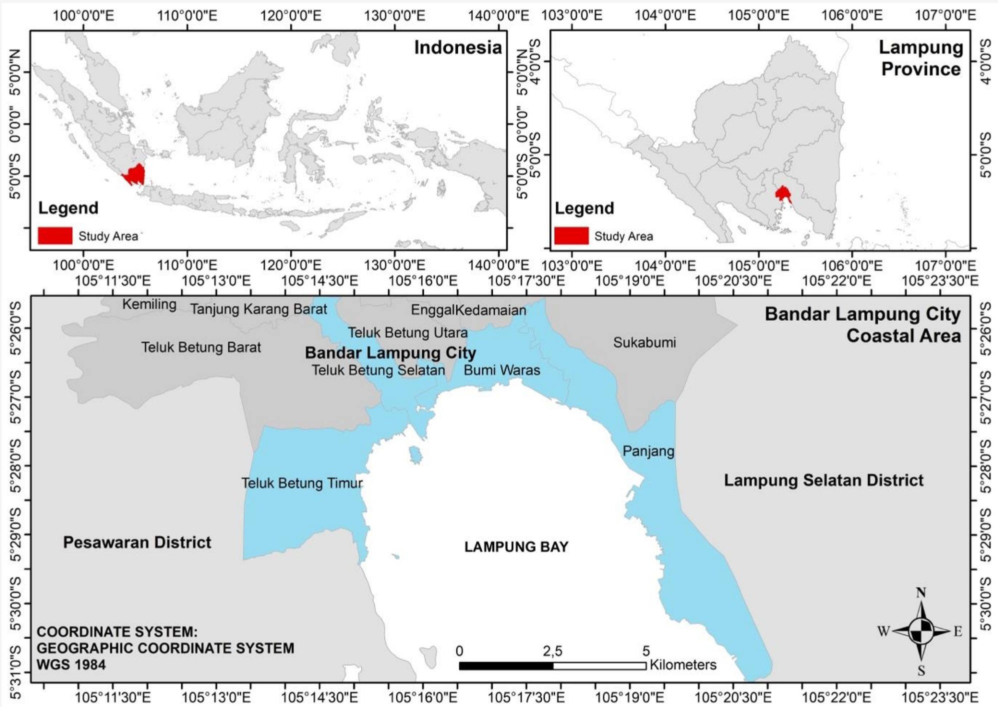

Figure 1: Coastal area of Bandar Lampung City, Indonesia

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The city of Bandar Lampung receives an average annual rainfall of between 1,500 and 2,000 mm, with a uniform distribution across its entire territory. The coastal areas of the city are characterized by a high population and dependency ratio, which renders them particularly susceptible to social disruption in the event of a disaster [23]. Bandar Lampung City is a coastal urban area with a relatively high population density and situated in close proximity to Lampung Bay. Tidal flooding has a considerable impact on urban activities in the coastal areas of Bandar Lampung City. The relatively flat topography of the area increases the potential for damage from tidal flooding. Tidal flooding in Bandar Lampung City's coastal areas typically persists for a period of 2-3 hours, resulting in inundation of roads and residential areas [16]. This results in the disruption of utility services and damage to household property. The coastal area of Bandar Lampung City covers approximately 38.12 km², representing 19.33% of the city's total area. This area is particularly susceptible to disasters due to the particular characteristics of its physical geography, social structure, economic systems, and environmental conditions [24]. The susceptibility of coastal areas to such disasters can also have a detrimental impact on the various land uses that are prevalent in these regions [1] and [25]. It has been shown that disruptions to land use in coastal areas have the potential to destabilize the ecosystems that exist there. This will consequently result in further environmental degradation and the emergence of additional environmental issues [26]. Figure 2 depicts the land use and land cover patterns observed in the coastal area of Bandar Lampung City.

The coastal regions of Bandar Lampung are primarily defined by the presence of urban settlements and undeveloped shrubbery. Moreover, the eastern section of the coastal zone is home to a number of industrial, commercial, and office buildings, particularly in the Bumi Waras and Panjang subdistricts. Furthermore, a medium-density primary lowland forest is present, though it is not directly adjacent to the coastline. Other land uses include port activities situated in the Panjang subdistrict, as well as other open-pit mining operations located in the Teluk Betung Timur and Bumi Waras subdistricts. In addition to the various residential buildings, there are settlements located in close proximity to the coastline that are inhabited by fishermen. Many houses in these areas are poorly built and often considered illegal or slum housing. When these informal settlements are located in flood-prone areas, it makes the people living there even more vulnerable to tidal flood hazards [27].

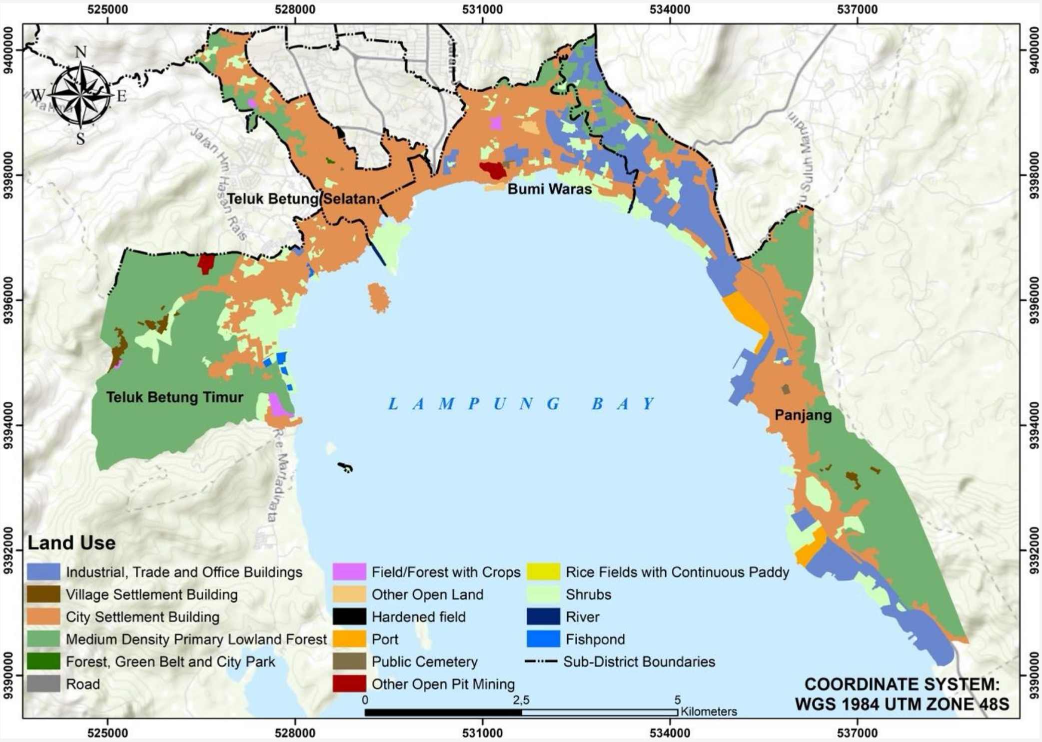

Figure 2: Land Use and Land Cover (LULC) of Bandar Lampung City coastal area

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2.2 Materials and Methods

This study employs three scenarios for tidal flood inundation modelling, which have been adjusted to align with the available tidal height data for the coast of Bandar Lampung City. The tidal flood inundation modelling scenarios used in this study are presented in Table 1. This study employs an in-depth interview technique to elicit information from respondents. The sampling method used was purposive sampling, which was used to identify key informants who were able to provide detailed descriptions of the tidal flood hazard in Bandar Lampung City coastal area. The research included 10 key informants, including the head of the urban village, subdistrict heads, representatives from the affected communities, and representatives from the Bandar Lampung City Marine and Fisheries Agency. The interviews were conducted for the purpose of obtaining data on the history of tidal flood events (including the minimum tidal flood height value), the impact of tidal floods on various sectors (including socio-economic), the characteristics of tidal floods (intensity, frequency, depth), how to adapt during floods, how to anticipate and mitigate (early warning systems, evacuation), and the mitigation strategies that have been implemented by the community and local government in order to reduce the risk of future tidal flooding. This data is then utilized as supplementary information for the spatial modeling of tidal flood hazards.

The value of the low tide level (Z_0) on the coast of Lampung Bay used in this study was obtained from the Centre for Research and Development of Marine and Coastal Resources, Ministry of Marine Affairs and Fisheries. This value was then validated using the following formula [28].

$$Z_0 = 1{,}2\ (M_2+S_2+K_2) \quad \text{Equation 1}$$

Description:

Z_0 = Low Tide Level Value
M_2 = Principal Lunar (semi-diurnal)
S_2 = Principal Solar (semi-diurnal)
K_2 = Luni-Solar (semi-diurnal)

M_2, S_2, and K_2 are the harmonic components of tides that can be used to calculate the value of the low tide level (Z_0). M_2 (Principal Lunar) is a component based on the movement of the moon, S_2 (Principal Solar) is a component based on the sun movement, and K_2 (Luni-Solar) is a component based on the sun and moon movement [29]. Diurnal tides manifest on two occasions within the span of a single day.

The highest tide of full condition obtained from the BMKG Maritime Meteorological Station Class IV Panjang is presented in the form of tidal data for a year in 2022, with data provided for every hour, day, and month. This study focuses on the analysis of the highest tide data recorded along the coast of Bandar Lampung City. The data indicate that the highest full tide on the coast of Bandar Lampung City is 160 cm (equivalent to 1.6 m). The development of a Geographic Information System (GIS) for urban hydrology applications, particularly in the creation of models, is a viable and advantageous approach. The study employed a digital elevation model (DEM), inundation height scenario data, and administrative boundaries to create a tidal flood inundation model. Furthermore, the results of the flood inundation model were overlaid with land use maps to determine the impact of each inundation scenario on land use in the coastal areas of Bandar Lampung City. Moreover, the flood inundation model was classified into three categories according to the level of hazard: low, medium, and high. These categories were assigned to correspond with the three inundation scenarios (Table 2).

Table 1: Modelling scenario of tidal flood inundation in the coastal area of Bandar Lampung City

Scenario (cm)	Description	Source
10	The Minimum Tidal Flood Height Value	Interviews
43	Low Tide Value (Z_0)	Centre for Research and Development of Marine and Coastal Resources, Ministry of Marine Affairs and Fisheries
160	The Highest Tide Value During Full Moon Conditions	BMKG Maritime Meteorological Station Class IV Panjang

Table 2: Classification of tidal flood hazard index based on inundation height scenario [30]

No.	Inundation Height Scenario (cm)	Index Score	Hazard Classification
1	10	1	High
2	43	0.66	Medium
3	160	0.33	Low

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It is presumed that coastal regions in close proximity to the sea exhibit a lower topographic profile in comparison to those situated at a greater distance from the shoreline. Consequently, in scenarios of limited inundation, areas situated at lower elevations and in closer proximity to the source of inundation will experience the initial effects. The source of inundation is the result of sea level tides. Tidal flood hazard modeling employs a classification system based on inundation height and hazard index inputs. The model generates a series of tidal inundation areas for each specified inundation height scenario, which are subsequently classified according to a hazard index ranging from 0 to 1. Each tidal flood hazard index is associated with a corresponding hazard intensity, expressed in terms of inundation height and inundated area. It can thus be determined that the areas flooded by the minimum flood tidal height (10 cm) are classified as high hazard areas, those flooded by Z_0 (43 cm) are classified as medium hazard areas, and those flooded by the highest tidal height (160 cm) are classified as low hazard areas. The spatial analysis in this study was conducted using ArcGIS 10.8 software and the Raster Calculator Analysis tool, employing mathematical equations:

$$[RasterDEM] \leq [Scenario\ X]$$

Equation 2

The Digital Elevation Model (DEM) data utilized in this study is DEMNAS, a product of the Geospatial Information Agency that provides elevation data in Indonesia with a resolution of 0.27-arcsecond. To extract the DEM according to the specified research location, the "Extract by Mask" feature in ArcGIS software was utilized. Moreover, the text provided the minimum and maximum elevations at the study location, which were then employed in the calculation of the elevation of the coastline or the outer administrative boundary of the study area.

The non-inundated areas within the raster results were subsequently removed through the process of reclassification. In this instance, the value of 0, which represents the absence of inundation, was transformed into a designation of "No Data," thereby eliminating all non-inundated areas. Subsequently, the raster was transformed into a polygon through the utilization of conversion tools, thereby eliminating areas that are not contiguous with the coastline. If the preceding steps were successful, the process continued with the "Select by Location" tool, which was used to overlay the results of the reclassified inundation with the coastline. The "Intersect" method was employed to determine the area of land inundated by tidal floods, which was overlaid with the land use map.

Additionally, the findings of the tidal flood hazard mapping were integrated with the data from the field observations concerning the measures taken to adapt to and mitigate the impact of tidal flooding in the study area. The research flow is illustrated in Figure 3.

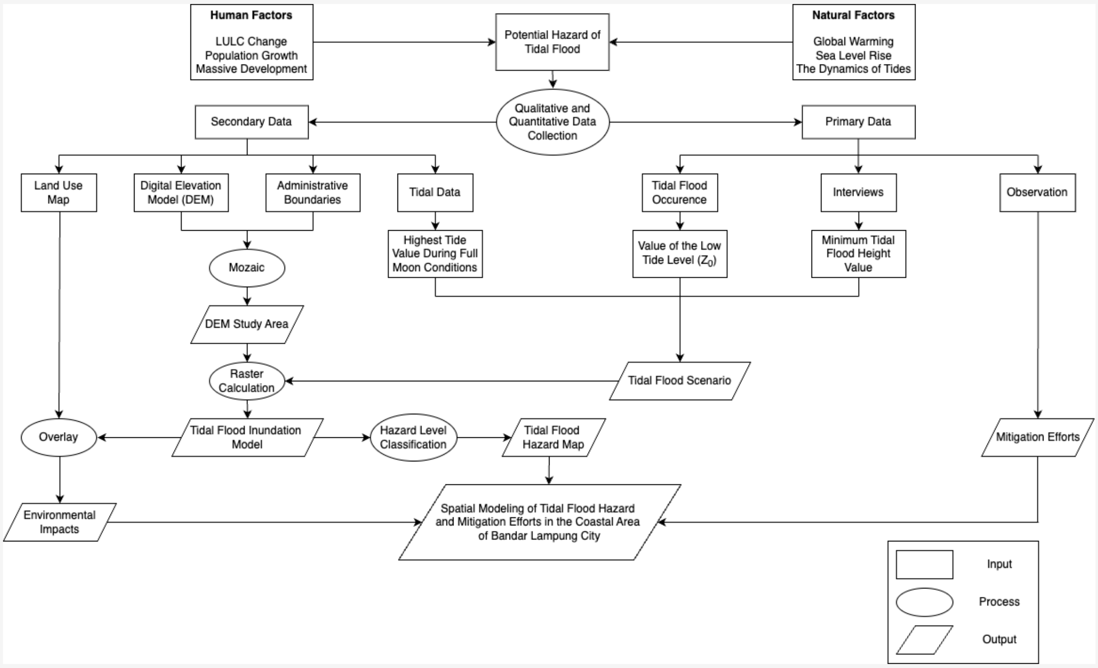

Figure 3: Flowchart of research methodology

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3. **Results and Discussion**

3.1 Tidal Flood Inundation Modeling

The three scenarios, 10 cm, 43 cm, and 160 cm, delineate the extent of inundation. The model is based on the assumption that no significant geological events, such as volcanic eruptions or earthquakes, will alter the topography of the study area. In addition, it is presumed that governments or households will not introduce supplementary measures with the aim of mitigating the impact of tidal flooding. Figure 4 illustrates the distribution of each inundation scenario.

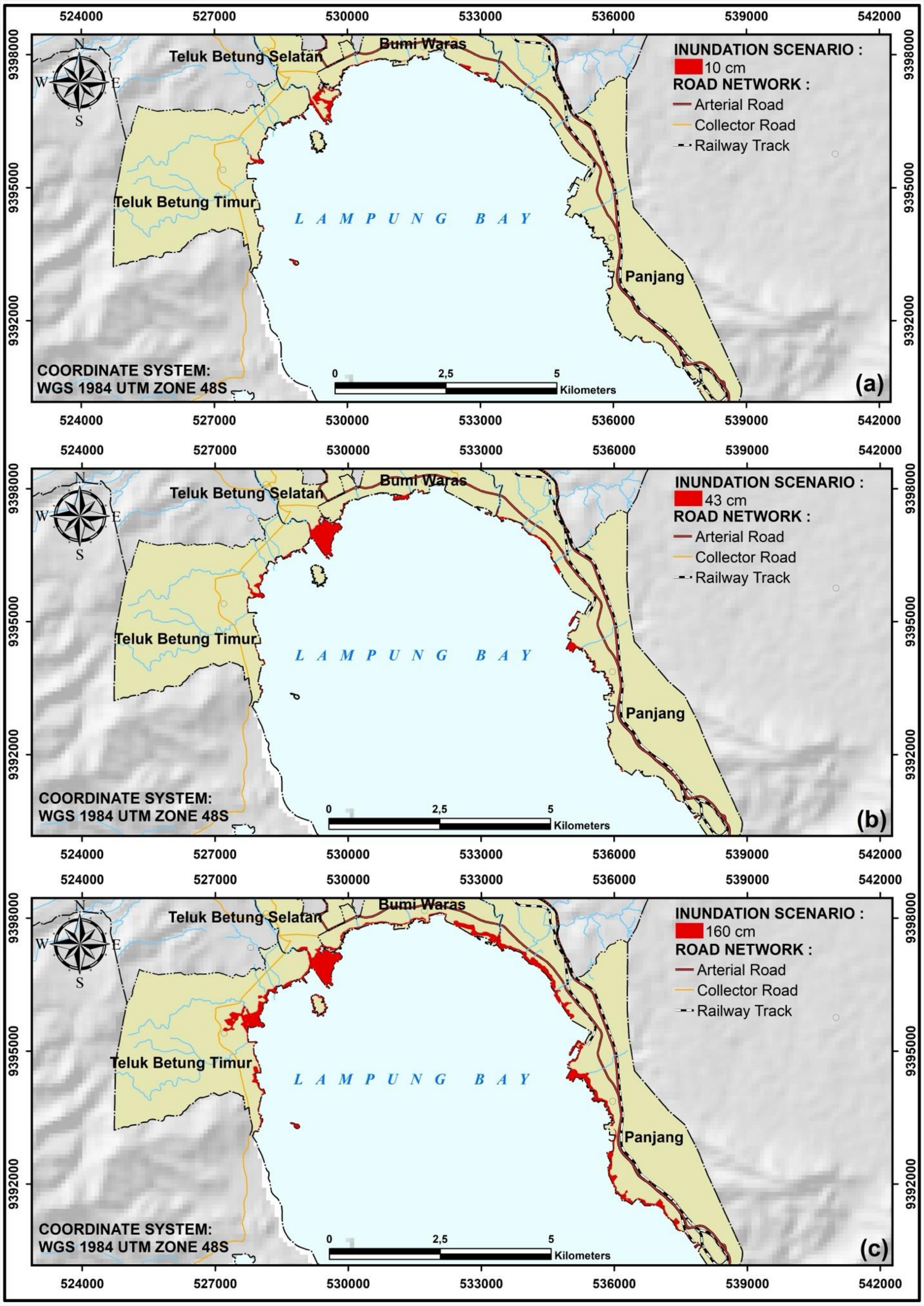

Figure 4: Tidal flood inundation scenario in Bandar Lampung City coastal area: (a) 10 cm (b) 43 cm (c) 160 cm

The inundation modeling results for the Teluk Betung Timur Subdistrict indicate that the area of inundation is 6.17 hectares (0.42%) in the 10-centimeter scenario, 10.13 hectares (0.68%) in the 43-centimeter scenario, and 46.29 hectares (3.12%) in the 160-centimeter scenario. In accordance with the findings of the inundation modeling conducted in Teluk Betung Selatan Subdistrict, the 10 cm scenario indicates 15.59 ha (4.11%) of inundated areas, the 43 cm scenario indicates 31.67 ha (8.36%) of inundated areas, and the 160 cm scenario indicates 34.91 ha (9.21%) of inundated areas. In the Bumi Waras subdistrict, the 10 cm scenario resulted in 4.77 ha (1.27%) of inundated area, while the 43 cm and 160 cm scenarios resulted in 10.8 ha (2.88%) and 34.91 ha (9.21%) of inundated area, respectively. Panjang subdistrict, the largest coastal subdistrict in Bandar Lampung City, exhibited inundated areas of 12.64 ha (0.80%) under the 10 cm scenario, 14.62 ha (0.93%) under the 43 cm scenario, and 60.85 ha (3.87%) under the 160 cm scenario. Table 3 shows the area inundated by tidal floods in Bandar Lampung City coastal area.

The inundation modelling results suggest that Teluk Betung Selatan and Bumi Waras are the subdistricts in the coastal area of Bandar Lampung City that are most susceptible to tidal flooding. Teluk Betung Selatan and Bumi Waras subdistricts are predominantly covered by built-up areas, including trade and service areas, dense residential areas for fishermen, and urban residential areas situated in close proximity to the administrative center of Bandar Lampung City and Lampung Province [31]. Both subdistricts have the highest population density in the coastal areas of Bandar Lampung City [32]. This is significant because areas with diverse activities, numerous residential buildings, and high population density are at an elevated risk of disaster losses due to tidal flooding hazards [33] and [34].

3.2 Impact of Tidal Flooding on Land Use

Land use is a crucial factor in determining vulnerability to flooding [35]. The effects of coastal flooding differ across different types of land use. Table 4 presents land use area inundated under the 10 cm, 43 cm, and 160 cm scenarios. The most extensive inundation was experienced by shrubs, which covered 98.85 hectares, while settlements covered 38.84 hectares.

Table 3: Inundated area based on inundation height scenarios in Bandar Lampung City coastal area

Sub-district	Inundation Height Scenarios (cm)	Inundation Area (ha)	Sub-district Area (ha)	Percentage of Inundation Area (%)
Teluk Betung Timur	10	6.17	1,483	0.42
	43	10.13		0.68
	160	46.29		3.12
Teluk Betung Selatan	10	15.59	379	4.11
	43	31.67		8.36
	160	34.91		9.21
Bumi Waras	10	4.77	375	1.27
	43	10.8		2.88
	160	30.9		8.29
Panjang	10	12.64	1,575	0.80
	43	14.62		0.93
	160	60.85		3.87
	Total	**172.95**	**3,812**	**4.54**

Table 4: Area of Land Use and Land Cover (LULC) affected by tidal flooding

No.	Land Use / Land Cover	Inundation Area against Land Use (ha)		
		10 cm	**43 cm**	**160 cm**
1	Shrubs	22.22	43.41	98.85
2	Settlements	8.44	13.58	38.84
3	Industry	5.34	6.49	21.17
4	Port	0.11	0.21	4.06
5	Medium-density Primary Land Forest	0.06	0.26	2.24
6	River	0.21	0.26	0.41
7	Tourism	0.19	0.23	0.95
8	Open Area	2.60	2.78	5.65
9	Fish Ponds	-	-	0.76
10	Fields with Secondary Crops	-	-	0.02
	Total	**39.17**	**67.22**	**172.95**

The inundation of residential areas by floodwater can have a disruptive effect on human activities and have a detrimental impact on environmental hygiene and human wellbeing. As a consequence of the aforementioned factors, settlements represent a particularly susceptible land use in the coastal areas of Bandar Lampung City, given the significant flood hazards they face [36]. Figure 5 illustrates the impact of varying inundation levels on land use and land cover (LULC) patterns. The impacts of tidal flood inundation vary between sub-districts. In the Teluk Betung Timur subdistrict, shrubland represents the land use most significantly impacted by inundation, irrespective of the inundation scenario. In the 10 cm scenario, 3.59 ha of shrubland were affected, rising to 6.31 ha in the 43 cm scenario and 29.48 ha in the 160 cm scenario. Additionally, urban residential buildings are significantly impacted, with an area of 13.38 hectares affected in the 160 cm scenario. In the Teluk Betung Selatan subdistrict, shrubs represent the most significantly impacted land use in all three inundation scenarios, with affected areas of 13.06 ha, 27.79 ha, and 27.80 ha, respectively, for the 10 cm, 43 cm, and 160 cm scenarios.

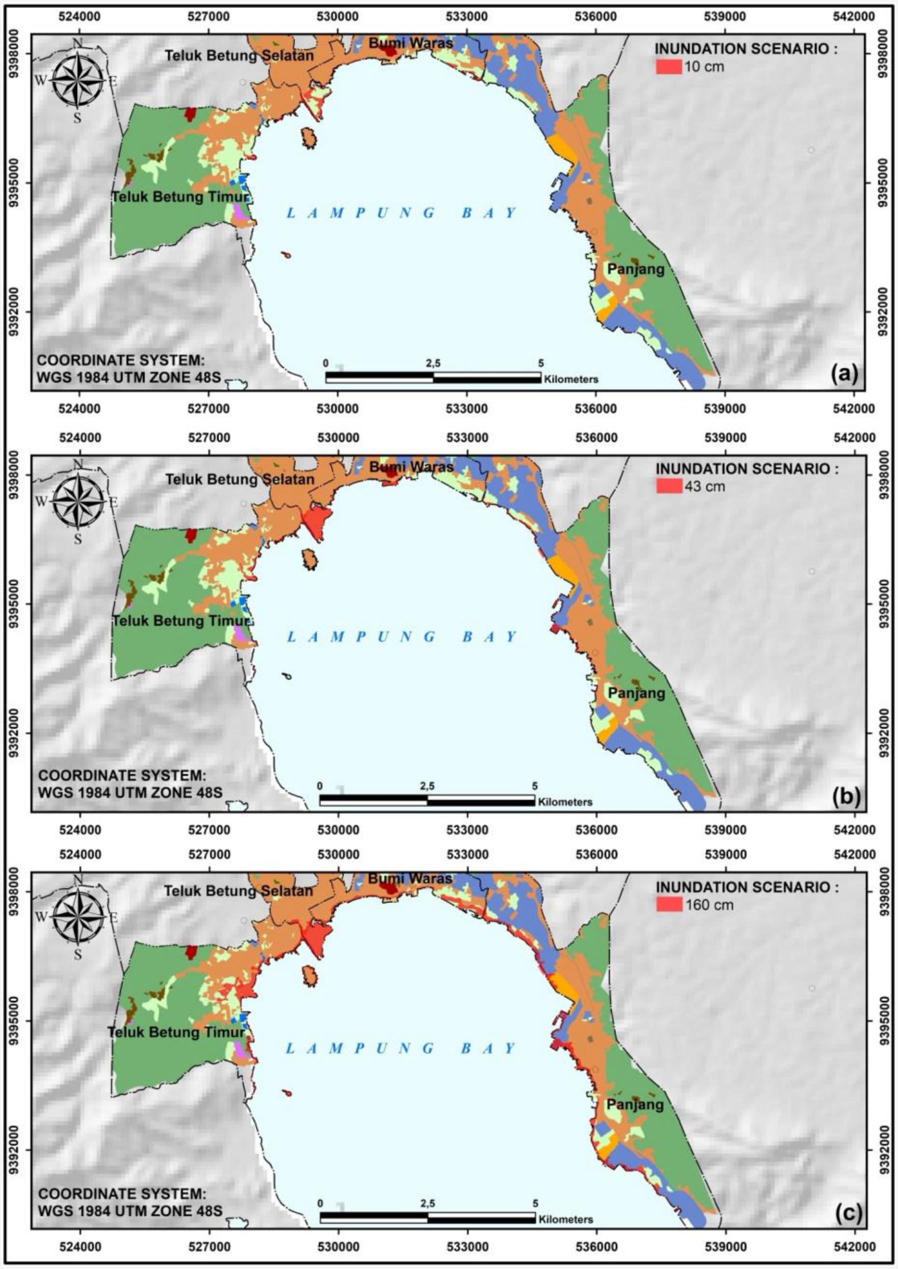

Figure 5: Land Use and Land Cover (LULC) areas affected by different inundation levels

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Furthermore, the 160 cm scenario has an additional impact on settlements, encompassing an area of 7.11 hectares.

In the case of the Bumi Waras subdistrict, the extent of the affected area varies slightly depending on the specific scenario under consideration. In all three inundation scenarios, settlements represent the dominant feature of the affected area. The 10 cm scenario affects 1.72 hectares. The 43 cm scenario affects 3.87 hectares. The 160 cm scenario affects 8.65 hectares. Furthermore, the subdistrict also encompasses shrubbery and other open land. In the Panjang subdistrict, industrial land use represents the predominant land use type within the area affected by each tidal flood scenario. The affected area for this land use type is 5.34 ha in the 10 cm scenario, 6.49 ha in the 43 cm scenario, and 21.17 ha in the 160 cm scenario. In the Panjang subdistrict, the second largest affected land use is shrubs.

3.3 Classification of Tidal Flood Hazard Levels

A tidal flood hazard classification was conducted with the objective of identifying the most vulnerable areas to tidal flooding based on a set of defined parameters, which were affected by tidal flooding in the coastal area of Bandar Lampung City. The results of the hazard mapping process enabled the delineation of the affected area, thus providing a foundation for the implementation of adaptation and mitigation strategies aimed at reducing the impact of potential disaster losses in sub-districts vulnerable to tidal flooding. This was based on the findings of the inundation modelling. According to Figure 6, the scenario with a 10 cm inundation is classified as high hazard due to its proximity to the coastline and the rapid inundation that occurs during high tide. The scenario with a 43 cm inundation is classified as medium hazard, while the scenario with a 160 cm inundation is classified as low hazard. This is due to the fact that in the 43 cm and 160 cm scenarios, the inundation will undoubtedly traverse the area that was inundated in the 10 cm scenario. Therefore, the intensity of tidal floods increases as the inundation height decreases. Table 5 presents the areas affected by tidal floods in Bandar Lampung City coastal areas, categorized by scenario and hazard class.

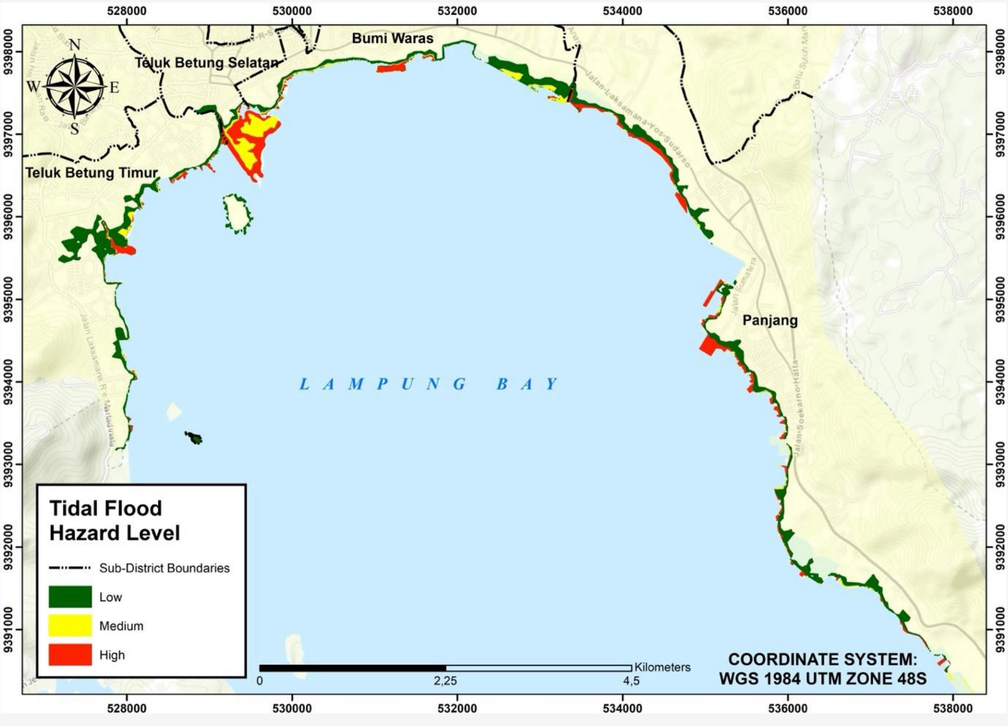

Figure 6: Tidal flood hazard in Bandar Lampung City coastal area

Table 5: Area inundated by scenario and hazard class

Scenario (cm)	Hazard Classification	Index Score	Inundation Area (ha)
10	High	1	39.17
43	Medium	0.66	28.05
160	Low	0.33	105.73
		Total	**172.95**

A classification based on hazard level reveals that the Teluk Betung Timur Subdistrict is predominantly classified as high hazard, encompassing an area of 6.17 hectares. This is followed by medium hazard, which covers an area of 3.96 hectares, and low hazard, which covers an area of 36.16 hectares. Similarly, the Teluk Betung Selatan Subdistrict is primarily classified as high hazard, encompassing an area of 15.59 hectares, followed by medium hazard, which covers an area of 16.08 hectares, and low hazard, which covers an area of 3.24 hectares.

The Bumi Waras subdistrict exhibits a distribution of high hazard class covering 4.77 hectares, medium hazard class covering 6.03 hectares, and low hazard class covering 20.1 hectares. Meanwhile, the largest coastal area in Bandar Lampung City is situated within the boundaries of the Panjang subdistrict, which has a distribution of high hazard class covering 12.64 ha, medium hazard class covering 1.98 ha, and low hazard class covering 46.23 ha. As illustrated in Figure 5, an increase in the level of hazard may be indicated by the presence of a low-altitude area [37]. The topography of coastal areas in close proximity to the sea is typically lower than that of areas situated at a greater distance from the shoreline. It can be reasonably deduced that in the event of the lowest inundation height scenario (10 cm), the areas initially affected are those of the lowest elevation and in closer proximity to the source of the inundation. Consequently, in this study, the areas encompassed by the high hazard index are those affected by inundation height scenarios spanning from the smallest (10 cm) to the largest (160 cm).

3.4 Adaptation and Mitigation Efforts to Tidal Flood Hazards in Bandar Lampung City Coastal Area

The findings of this research indicate that settlements situated in close proximity to the coastline are subject to significant flood inundation as a result of tidal flooding. In order to mitigate the impact of tidal flooding on settlements, a range of adaptation measures can be implemented [38]. The most prevalent approach is to elevate the ground level of the residence (Figure 7) or construct a multi-story dwelling unit [39] and [40]. Some communities have also constructed dams along the coastline to safeguard their residences from inundation [35] and [38].

Moreover, conservation initiatives can be implemented to attenuate the impacts of tidal flooding. One such effort involves the planting of yard plants around the house, which is expected to accelerate infiltration in floodplain areas [39]. In order to achieve this objective, it is essential to cultivate plant species that are capable of surviving in saline conditions. The conservation of mangroves can be an effective method of establishing a natural barrier that prevents abrasion and tidal flooding in coastal areas [41]. Mangroves represent a primary line of defense against a range of coastal threats [42]. The capacity of these organisms to flourish in diverse coastal ecosystems indicates their resilience to threats, or at the very least, their capacity to recuperate from substantial impacts [43]. Lampung Province is committed to ensuring the conservation and sustainable utilization of oceans, seas and marine resources for sustainable development [44]. The coastal area has been designated as a local protected area [45]. It is therefore evident that the implementation of a mitigation plan is essential. This can be achieved through the utilization of spatial planning and control strategies that are aligned with the objectives of sustainable coastal management plans.

A variety of approaches can be employed to develop spatial planning strategies with a focus on disaster mitigation. Such strategies include the regulation of the realignment of the Bandar Lampung City coastline, the creation of green lanes as a form of buffer in coastal areas, and the conversion of land functions into mangrove areas [46]. Additionally, there is a need to relocate illegal buildings and residents who are threatened by tidal floods.

Figure 7: Community adaptation by raising the house building in Bandar Lampung City coastal area

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It is crucial to guarantee that these strategies are executed in a balanced and objective manner, free from any form of bias or subjective evaluation. Spatial control to anticipate tidal flood hazards can be achieved through three main strategies: (1) prohibiting physical development in tidal flood hazard areas, (2) applying incentives and disincentives to certain functional areas, and (3) regulating building density through building codes such as basic building coefficients, building floor coefficients, and basic green coefficients.

4. Conclusion

Tidal flood hazard modelling can be achieved through the utilization of three inundation scenarios, based on the minimum tidal flood height, the value of the low tide level (Z_0), and the maximum tidal height. This approach aims to obtain the most realistic scenario for formulating future coastal management plans. The study found that in the 160 cm inundation scenario, Panjang subdistrict experienced the most extensive inundation area due to its residential, industrial, trade, and port activities. The most affected land use types were shrubs, which accounted for 57.16% of the total inundated area, and settlements, which accounted for 22.46%. Tidal flooding has significant environmental impacts, including damage to infrastructure, household property, and soil and water pollution. The coastal management plan is oriented towards the resolution of issues resulting from the effects of tidal flooding, in conjunction with the Regional Spatial Plan of Bandar Lampung City. In order to mitigate the risk of tidal floods in the coastal areas of Bandar Lampung City, a number of potential programmes have been identified. These include the raising of building floors or the construction of multi-storey houses, the implementation of conservation measures in residential areas, and the execution of mitigation plans through the utilization of spatial planning and control strategies. To achieve this, further study of disaster-prone spatial zoning that accommodates the distribution of disaster hazards in coastal areas is required so that structural and non-structural mitigation plans can be properly implemented.

Acknowledgements

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