Flood Mitigation Strategies in Rajabasa Subdistrict, Bandar Lampung and Analysis of On-Site Flood Conditions

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Abstract

Flooding in Rajabasa Subdistrict, Bandar Lampung City, is a recurring urban disaster that intensifies during periods of high rainfall. This study aims to identify the dominant causes of flooding and to formulate appropriate mitigation strategies based on spatial analysis, community interviews, and hydrological modeling. The research employed Geographic Information System (GIS)-based spatial analysis, field observations, structured interviews with affected residents, and hydrodynamic simulations using the HEC-RAS model to evaluate drainage capacity and flow behavior. The results indicate that flooding is primarily caused by inadequate drainage systems, uncontrolled land-use conversion that reduces infiltration areas, and sediment and waste accumulation within drainage channels. Spatial analysis reveals that flood-prone zones are concentrated in low-lying, densely populated areas with flat topography and poor drainage conditions. Based on these findings, mitigation strategies emphasizing drainage normalization, infiltration enhancement, riverbank vegetation, and community-based waste management are proposed. The integration of spatial analysis and hydrological modeling provides a scientific basis for flood mitigation planning in urban environments.

Keywords: Flood Mitigation, GIS, HEC-RAS, Urban Flooding, Spatial Analysis

I. INTRODUCTION

Flooding constitutes a recurrent natural hazard in Rajabasa Subdistrict, Bandar Lampung City, particularly during periods of high-intensity rainfall.

This issue is significantly aggravated by the limited capacity of the local drainage infrastructure to accommodate excessive water flow. In addition, the conversion of natural water catchment areas into residential developments and the persistently low levels of public awareness regarding proper waste disposal practices have further intensified flood vulnerability (Agustri & Hut, 2020). The consequences of flooding are multifaceted, encompassing not only structural damage to residential buildings and public infrastructure, but also considerable disruptions to the socio-economic activities of the affected communities (Anwar, Ningrum, & Setyasih, 2022; Yunida, Kumalawati, & Arisanty, 2017). Prolonged inundation in several low-lying areas has led to substantial material losses and a marked decline in living standards.

In light of these challenges, there is a pressing need for the implementation of long-term and sustainable flood mitigation strategies. A spatial planning approach that integrates considerations of hydrological capacity, along with the enhancement of drainage systems, offers

a promising direction. Furthermore, public education and the active participation of local communities in environmental management are critical components in fostering flood resilience (Jamanti, 2014; Marfai & Cahyadi, 2014). This study seeks to identify the principal causes of flooding in the study area, to evaluate existing mitigation efforts, and to formulate spatially-informed policy recommendations aimed at developing a more disaster-resilient urban environment.

II. RESEARCH METHODOLOGY

This study applied a mixed-methods approach integrating qualitative and quantitative analyses to investigate flood occurrence and mitigation in Rajabasa Subdistrict. Spatial analysis was conducted using satellite imagery, topographic maps, land-use maps, and administrative boundary data to identify flood-prone areas and physical characteristics influencing runoff. Field surveys were carried out to verify drainage conditions, channel dimensions, and sediment accumulation.

Hydrological and hydraulic analyses were performed using the HEC-RAS software to simulate water flow behavior and assess the capacity of existing drainage channels under high rainfall conditions. Model inputs included channel geometry, flow direction, and runoff characteristics derived from spatial data and field observations. Community interviews were conducted with residents frequently affected by flooding to obtain information on flood frequency, duration, and perceived causes. The integration of spatial, hydrological, and socio-environmental data enabled a comprehensive evaluation of flood risk and mitigation needs.

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III. RESULTS AND DISCUSSIONS

The occurrence of flooding in Rajabasa Subdistrict is influenced by a combination of natural and anthropogenic factors. Topographically, the study area consists of upland zones in the northern part and low-lying areas in the central and southern sections. Rainwater from higher elevations flows toward these lowlands, where flat slopes and clay-dominated soils with low infiltration capacity contribute to water accumulation. High rainfall intensity further increases surface runoff, exceeding the capacity of existing drainage systems. Anthropogenic factors significantly exacerbate flood conditions. Rapid land-use conversion from natural infiltration areas to residential and commercial zones has reduced the ability of the soil to absorb rainfall. In addition, drainage channels are generally narrow, shallow, and poorly maintained, with sedimentation and domestic waste frequently obstructing water flow. Spatial flood hazard mapping indicates that high flood vulnerability is concentrated in densely populated areas with inadequate drainage infrastructure, particularly in Rajabasa Nunyai and Rajabasa Raya Subdistricts.

Hydrological simulations using HEC-RAS demonstrate that the current drainage network is insufficient to convey peak runoff during heavy rainfall events. Overflow occurs when channel capacity is exceeded, leading to inundation of residential areas. These findings confirm that structural deficiencies in the drainage system, combined with unfavorable land-use patterns, are the primary drivers of recurrent flooding in the study area.

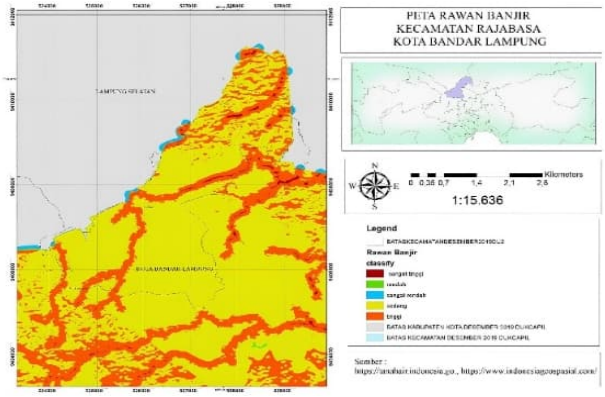

Figure 1. Flood-prone map of Rajabasa District, Bandar Lampung

Based on the results of spatial and hydrological analyses, flood mitigation in Rajabasa Subdistrict should be implemented through integrated structural and non-structural measures. Structural mitigation includes drainage normalization, channel widening, sediment removal, and the construction of infiltration wells and retention basins to reduce surface runoff. Riverbank greening using water-absorbent vegetation is recommended to enhance infiltration capacity and stabilize channel margins.

Non-structural mitigation focuses on improving environmental awareness and community participation through waste management programs and routine drainage maintenance. Disaster-responsive spatial planning is also required, emphasizing the protection of infiltration areas and

the integration of flood retention zones into urban development plans. These measures are expected to reduce flood frequency and intensity when implemented in a coordinated and sustainable manner.

The flood hazard map of Rajabasa Subdistrict reveals that high-risk areas are concentrated in specific locations, particularly those characterized by dense residential development and inadequate drainage systems. Several alleys identified as frequently affected include:

1. **Gang Ibrahim** (Rajabasa Induk Subdistrict): Ibrahim Alley, located in Rajabasa Induk Subdistrict, is one of the most frequently flooded areas in Rajabasa. The neighborhood lies on lowland terrain with dense residential settlements. The drainage system is narrow and often clogged by sediment and domestic waste, causing water to overflow during periods of heavy rainfall. In the most recent flooding event, approximately thirty houses were inundated. These conditions highlight the urgent need for drainage normalization and capacity enhancement to better accommodate runoff and prevent recurrent inundation during the rainy season.

Figure 2. Ibrahim Alley, Rajabasa Induk Subdistrict

2. **Gang Toyib** (Rajabasa Induk Subdistrict): Toyib Alley, also situated in Rajabasa Induk Subdistrict, experiences similar hydrological challenges. The drainage channels are small and poorly maintained, which prevents efficient runoff discharge. As a result, water frequently accumulates on the streets and in residential yards even during moderate rainfall. Flooding in this area has become a recurring issue during every rainy season. Drainage improvement through widening, dredging, and regular maintenance is necessary to ensure smoother water flow and reduce the frequency of flooding.

Figure 3. Toyib Alley, Rajabasa Induk Subdistrict

3. **Gang Haji Ismail** (Rajabasa Nunyai Subdistrict): Haji Ismail Alley in Rajabasa Nunyai Subdistrict is among the most flood-prone zones in the Rajabasa area. The site has drawn attention from local authorities, including a visit by the Acting Governor of Lampung, to evaluate river flow conditions and prioritize drainage improvements. The drainage system here is shallow and frequently obstructed by waste and sediment, leading to water overflow during heavy rain. Flooding in this area often disrupts residents' mobility and damages household property. Proper drainage rehabilitation, coupled with increased community awareness of waste management, is crucial to reduce flood impacts..

Figure 4. Haji Ismail Alley, Rajabasa Nyunyai Subdistrict

4. **Gang Marga Anak Tuha** (Rajabasa Raya Subdistrict): Marga Anak Tuha Alley, located in Rajabasa Raya Subdistrict, is identified as a high-risk flood zone. The primary causes include narrow drainage channels and sediment buildup, which reduce water discharge capacity. Flooding in this area has previously inundated dozens of

houses and boarding houses, with water levels reaching several tens of centimeters. Such events have damaged furniture, interrupted daily activities, and affected local livelihoods. Mitigation efforts should focus on drainage normalization, sediment removal, and the development of infiltration wells to manage runoff effectively.

Figure 5. Marga Anak Tuha Alley, Rajabasa Raya Subdistrict

5. **Gang Nunyai** (Rajabasa Subdistrict): Nunyai Alley in the Rajabasa Nunyai Subdistrict is classified as a highly flood-prone area due to inadequate drainage infrastructure and unfavorable topographical conditions. The drainage system in this area is shallow, narrow, and frequently clogged with sediment and household waste, which significantly hinders the proper flow of stormwater during periods of heavy rainfall. The relatively flat terrain further exacerbates water accumulation, leading to recurrent flooding that often lasts for hours or even days. These prolonged inundations disrupt residents' daily activities, damage household belongings, and create potential health risks due to stagnant water and poor sanitation

Figure 6. Nyunyai Alley, Rajabasa Subdistrict

6. **Gang Gelora** Persada (Rajabasa Raya Subdistrict): Gelora Persada Alley, located in Rajabasa Raya Subdistrict, is categorized as a critically flood-prone area. The drainage infrastructure is inadequate, with small channels frequently filled with sediment, and the flat terrain prevents rapid water discharge. During high-intensity rainfall, floodwaters quickly submerge the streets and nearby residences, sometimes cutting off road access. The area urgently requires comprehensive drainage normalization and expansion, as well as the installation of infiltration systems to increase soil absorption and mitigate severe flooding events.

Figure 7. Gelora Persada Alley, Rajabasa Subdistrict

Interviews with local residents revealed that the primary causes of flooding include poor rainwater management, high sedimentation in drainage channels, and low levels of public awareness regarding environmental sanitation. Many drainage pathways were found to be obstructed by domestic waste, leading to reduced water flow and widespread inundation.

In addition, land-use change-from natural infiltration areas to built-up residential and commercial zones-has exacerbated the flood risks. Land previously capable of absorbing rainfall is now covered by impervious infrastructure, resulting in increased surface runoff and reduced water retention capacity.

Mitigation Strategies

To reduce flood risk in Rajabasa Subdistrict, several mitigation measures are proposed:

1. Revitalization of Drainage Channels Normalization and widening of drainage networks to increase water-carrying capacity and reduce sediment buildup.
2. Riverbank Greening Initiatives Planting water-absorbent vegetation along riverbanks to minimize runoff and restore ecological function.

3. Environmental Literacy Improvement Ongoing community education on waste management and the importance of maintaining environmental cleanliness.
4. Disaster-Responsive Spatial Planning Development of spatial plans that integrate flood retention zones and early warning systems.

Hydrological simulations conducted using the HEC-RAS software suggest the necessity of redesigning the main water channels and constructing retention basins to accommodate peak runoff during heavy rainfall events. The success of these strategies depends heavily on coordinated efforts among local governments, community stakeholders, and academic institutions.

IV. CONCLUSIONS

Flooding in Rajabasa Subdistrict is primarily caused by inadequate drainage infrastructure, uncontrolled land-use change, and low environmental awareness among the community. Flood-prone areas are predominantly located in low-lying, densely populated zones with flat topography and limited drainage capacity. The integration of spatial analysis and HEC-RAS hydrological modeling demonstrates that existing drainage systems are unable to accommodate peak runoff during high rainfall events. Effective flood mitigation requires an integrated approach combining drainage system improvement, land-use regulation, infiltration enhancement, and active community participation. These findings provide a scientific basis for urban flood mitigation planning in Bandar Lampung.

RECOMMENDATIONS

In future flood hazard mapping, it is recommended to incorporate additional parameters such as soil type and proximity to river flow (buffer zones). Field validation is necessary to ensure the accuracy of inundation locations as indicated by the spatial data. Administrative boundary mapping should be represented in polygon format to clarify the spatial extent of the analysis.

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