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Spatial Analysis of Dengue Hemorrhagic Fever Case Distribution in West Java Province 2023

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ABSTRACT

Dengue Hemorrhagic Fever (DHF) is a communicable disease that poses a significant public health challenge in Indonesia. Research Objectives: This study aims to spatially analyze Dengue Hemorrhagic Fever (DHF) case distribution in West Java Province in 2023 using Incidence Rate (IR) and Case Fatality Rate (CFR) variables. Materials and Method: Data were obtained from the West Java Health Profile and the Central Bureau of Statistics, processed using Quantum GIS software. Research Results: The analysis results indicate that areas with high vulnerability to Dengue Hemorrhagic Fever (DHF) are predominantly urban regions, such as Bogor City, Sukabumi City, and Bandung City. Conclusions: This spatial visualization is expected to serve as a reference for policymakers in designing more effective Dengue Hemorrhagic Fever (DHF) control and prevention strategies. GIS-based information also facilitates a better understanding of health phenomena for readers.

Keywords: *Dengue Hemorrhagic Fever, Incidence Rate, Case Fatality Rate, Geographic Information System, Spatial Analysis*

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INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is a significant public health issue that demands serious attention, as it can lead to fatalities with a high Case Fatality Rate (CFR), especially during outbreaks. Dengue Hemorrhagic Fever (DHF) transmitted through mosquito bites of the Aedes genus, particularly Aedes aegypti or Aedes albopictus, can occur throughout the year and affect all age groups, both male and female. This disease is influenced by environmental conditions, climate, population density, and community behavior. The World Health Organization (WHO) reports that dengue cases have increased 30-fold over the last five decades, with an estimated 390 million infections annually, 96 million of which manifest clinically WHO (2023). In Southeast Asia, dengue represents a significant burden, particularly in densely populated countries like Indonesia, where environmental conditions and urbanization intensify transmission risks (Sekarrini et al., 2022).

In Indonesia, DHF remains a serious health issue, with annual outbreaks leading to thousands of cases and deaths. Despite efforts to reduce mortality rates, DHF is still prevalent due to climate variability, poor waste management, and limited community awareness (Kementerian Kesehatan Republik Indonesia, 2023).Based on data from the Ministry of Health, Dengue Hemorrhagic Fever (DHF) cases in West Java show significant annual fluctuations. From 2014 to 2023, the Dengue Hemorrhagic Fever (DHF) mortality rate exhibited a fluctuating trend but tended to decline, achieving the national target of <1%. This improvement is attributed to better healthcare facilities in terms of both quality and quantity. Similarly, morbidity rates also showed fluctuating trends from 2014 to 2023. Notable increases occurred in 2016, 2019, and 2022 compared to the preceding years. In 2016, the morbidity rate rose to 77 cases per 100,000 population compared to the previous year. In 2019, the morbidity rate of 47 cases per 100,000 population was higher than in 2018, which recorded 23 cases per 100,000 population. In 2022, the morbidity rate

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increased to 72 cases per 100,000 population compared to 2021. However, in 2023, the morbidity rate declined to 38 cases per 100,000 population, with a pattern of case surges occurring approximately every three years (Kementerian Kesehatan Republik Indonesia, 2023)

Information on the distribution of Dengue Hemorrhagic Fever (DHF) cases can be obtained using Geographic Information Systems (GIS). GIS maps provide insights into disease case numbers, case locations, and regions affected by the disease.(6) Thus, spatial analysis using GIS applications can help analyze health data to better understand disease phenomena in specific areas. This analysis method can also serve as an alternative analytical approach in health education (Taufiqurrahman, 2024).

This study aims to understand the spatial distribution of Dengue Hemorrhagic Fever (DHF) cases by developing a vulnerability map for Dengue Hemorrhagic Fever (DHF) in West Java Province in 2023 using the variables Incidence Rate (IR) and Case Fatality Rate (CFR) through GIS application. Spatial information derived from this study can serve as a surveillance dataset easily understood by DHF program managers. This research is expected to provide fundamental information for policymakers in designing programs and policies for controlling and reducing Dengue Hemorrhagic Fever (DHF) cases.

METHODS

This study is quantitative in nature and focuses on analyzing the spatial distribution of Dengue Hemorrhagic Fever (DHF) cases using Geographic Information Systems (GIS). The research was conducted in West Java Province, encompassing 27 districts and cities identified as vulnerable to DHF transmission. The study was carried out in 2024, utilizing secondary data from the 2023 West Java Health Profile and population data from the Badan Pusat Statistik (BPS) of West Java (Badan Pusat Statistik, 2023).

The population in this study consists of all districts and cities in West Java, while the sample includes all 27 districts and cities due to the comprehensive nature of the analysis. A total sampling technique was employed, as all available data points were included without selection. Data were collected in tabular form and processed using a scoring system to determine the level of vulnerability of each area. The scoring was based on key epidemiological indicators, including the Incidence Rate (IR) and Case Fatality Rate (CFR) of DHF cases. Each district or city was assigned a score for these indicators, with higher scores representing higher vulnerability. The scoring criteria involved categorizing IR and CFR into quintiles, assigning scores from the lowest to highest range. Additionally, population density was included as a contributing factor, with denser populations receiving higher scores.

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The cumulative score from these indicators was used to classify areas into different vulnerability levels. The classification was determined using the Jenks Natural Breaks Optimization, which identifies natural groupings within the data to minimize variance within each category. The cut-off values for risk categories were as follows: Low-risk areas: Cumulative scores within the lowest *natural break* threshold; Medium-risk areas: Scores falling between the first and second *natural breaks*; High-risk areas: Scores above the second *natural break*, indicating the highest vulnerability.

The processed data were then converted into Excel format and integrated into GIS software for spatial visualization and analysis. The primary software used was Quantum GIS version 3.14. The base map of West Java Province was sourced from the Geospatial Information Agency (BIG). Each variable's data were mapped using color gradients to indicate case distribution across districts and cities.

Spatial analysis was conducted using the overlay analysis technique, a geospatial method that integrates multiple thematic layers, including IR and CFR distributions. The final output was a DHF vulnerability map, categorizing areas into high-risk, medium-risk, and low-risk zones. This classification aids policymakers in prioritizing regions for DHF intervention strategies.

RESULTS

Dengue Hemorrhagic Fever (DHF) is a significant public health concern that requires serious attention due to its potential to cause fatalities, particularly in outbreak situations, with a high Case Fatality Rate (CFR). Dengue Hemorrhagic Fever (DHF) is transmitted through mosquito bites from the Aedes genus, primarily *Aedes aegypti* and *Aedes albopictus*, and can occur throughout the year, affecting individuals of all ages, both male and female. This disease is influenced by environmental conditions, climate, population density, and community behavior (Shepard et al., 2016).

Proper identification and recording of DHF cases are expected to facilitate more effective and systematic treatment of patients. These efforts can significantly reduce morbidity and mortality rates associated with DHF and its transmission within communities. Thus far, such measures are considered the most effective strategies for DHF prevention and control in society (Yuliana et al., 2022).

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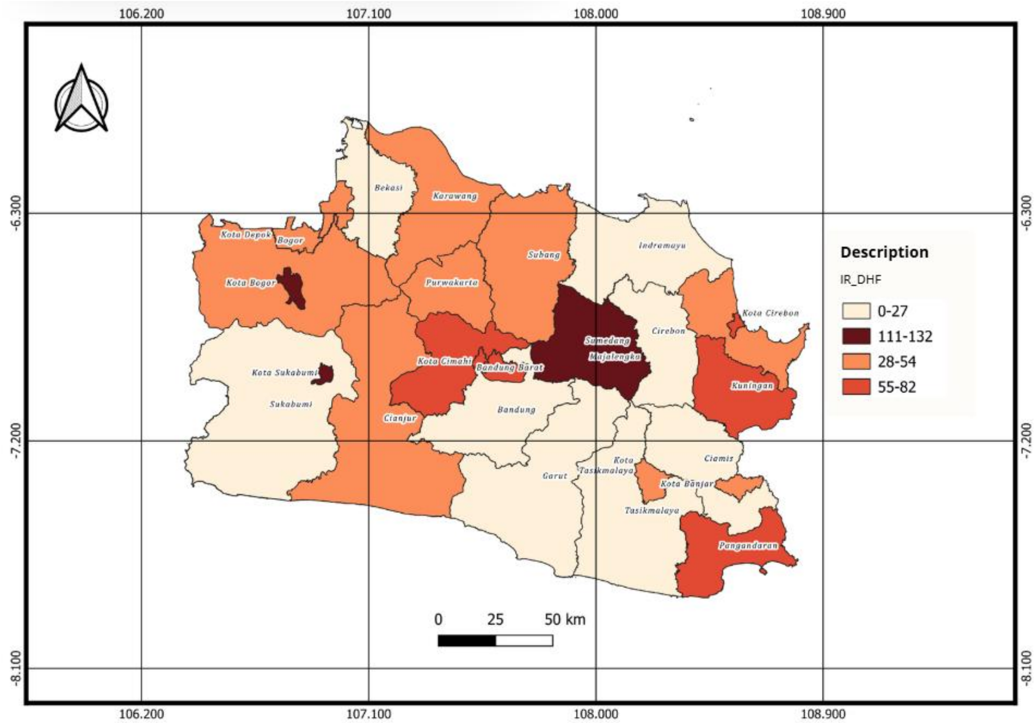
Figure 1. Map of Dengue Hemorrhagic Fever Incidence Rates (IR) in Districts and Cities of West Java Province in 2023



The figure above visualizes the Incidence Rate (IR) of Dengue Hemorrhagic Fever (DHF), representing the number of new cases identified and recorded per 100,000 population within a specific area (Kementerian Kesehatan Republik Indonesia, 2023). The IR serves as an indicator of morbidity. In the map, each district and city is categorized into five gradient levels based on the number of newly recorded DHF cases.

Darker color gradients on the map indicate areas with a higher number of new cases. The highest category falls within the range of 111–132 new cases per 100,000 population,

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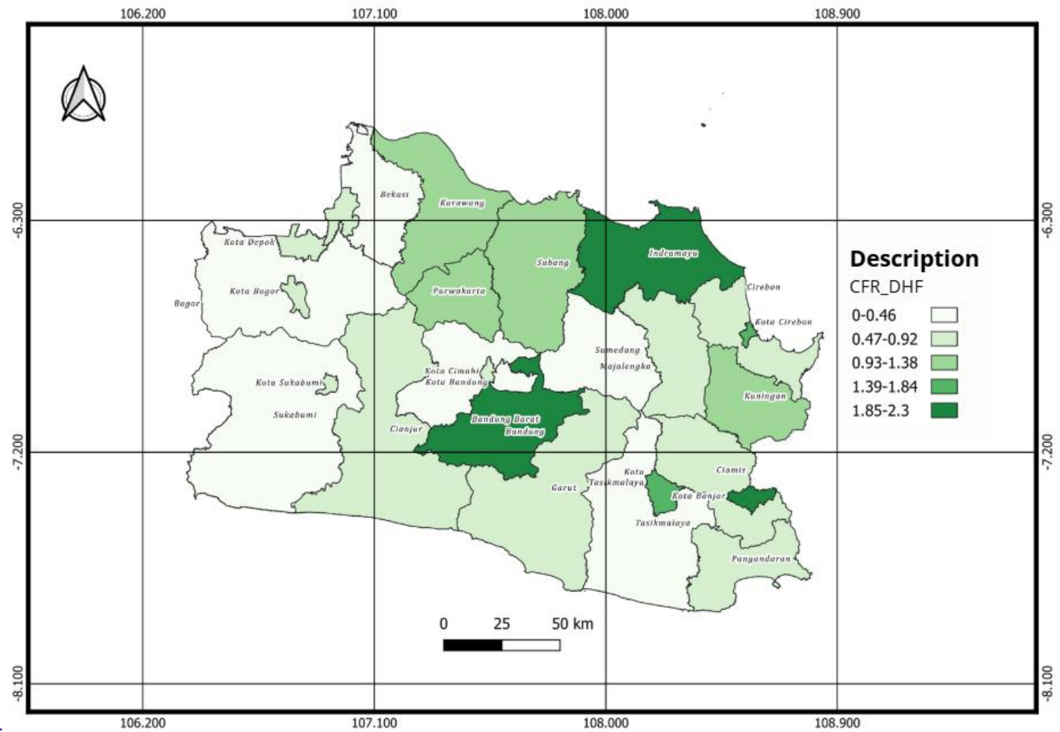
followed by the ranges of 83–110, 55–82, 28–54, and the lowest category at 0–27 new cases per 100,000 population. This categorization divides districts and cities in West Java Province into five levels based on the severity of DHF case incidence.

The highest morbidity rates for Dengue Hemorrhagic Fever (DHF) were recorded in three cities: Bogor City (132 cases per 100,000 population), Sukabumi City (124 cases per 100,000 population), and Sumedang Regency (110 cases per 100,000 population). Conversely, the lowest morbidity rates were observed in Sukabumi Regency (4 cases per 100,000 population) and Tasikmalaya Regency (5 cases per 100,000 population).

Figure 2. Map of Dengue Hemorrhagic Fever Case Fatality Rate (CFR) in Districts and Cities of West Java Province in 2023



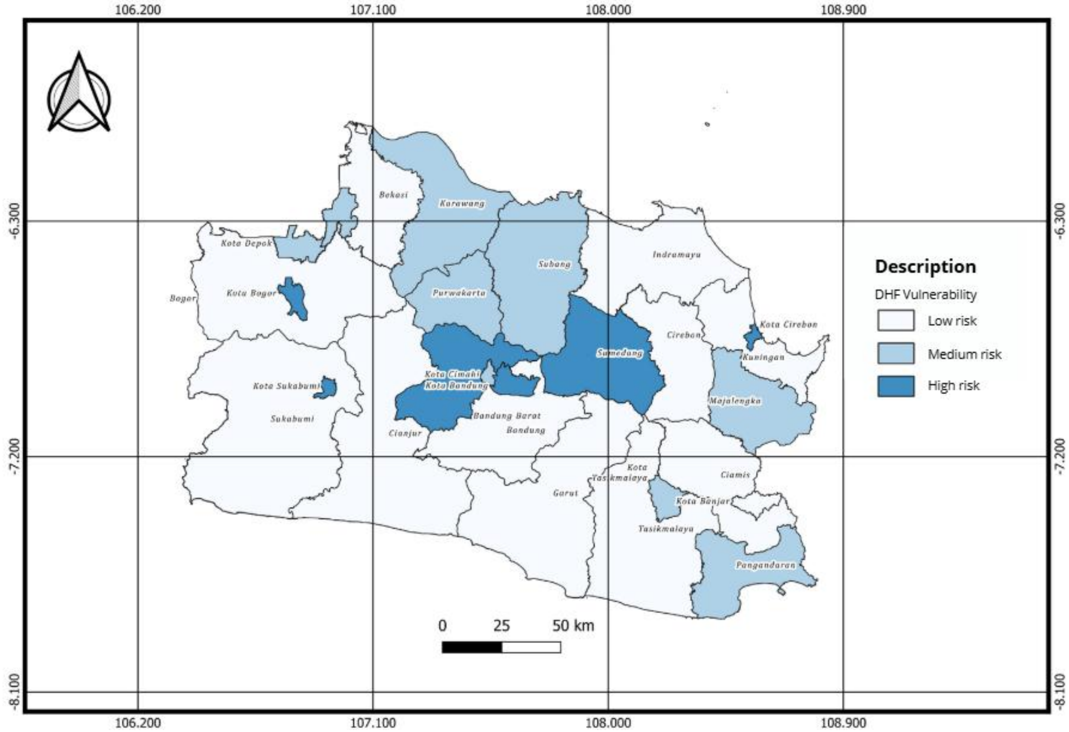
Case Fatality Rate (CFR) is an epidemiological measure used to describe the severity of a disease or condition. CFR is calculated as the percentage of deaths caused by a specific disease relative to the total number of confirmed cases of that disease within a given time period

Based on Figure 2, the Case Fatality Rate (CFR) of Dengue Hemorrhagic Fever in districts and cities of West Java Province is categorized into five levels, visualized using a color gradient. The gradient transitions from green to red, where red indicates higher CFR levels. The highest CFR level ranges from 1.85% to 2.30%, followed by Level 4 (1.39%–1.84%), Level 3 (0.93%–1.38%), Level 2 (0.47%–0.92%), and the lowest level, Level 1, ranges from 0% to 0.46%.

The vulnerability map for Dengue Hemorrhagic Fever (DHF) analyzed in this study is derived from two thematic maps defined as variables associated with disease severity. These maps include the Incidence Rate (IR) map, representing morbidity, and the Case Fatality Rate (CFR) map, representing mortality. The two thematic maps are overlaid using a spatial analysis technique to produce a composite vulnerability map or consequence level. Before applying the overlay technique, weighting is assigned to each variable to facilitate the interpretation of data in the Geographic Information System (GIS) application (Alfiyanti & Siwiendrayanti, 2021)

The vulnerability map for Dengue Hemorrhagic Fever (DHF) analyzed in this study is derived from two thematic maps, defined as variables related to disease severity. These maps include the Incidence Rate (IR) map, representing morbidity, and the Case Fatality Rate (CFR) map, representing mortality. The two thematic maps are combined using the overlay technique to produce a composite DHF vulnerability map or consequence level. The overlay technique is preceded by assigning weights to each variable to facilitate data interpretation within the Geographic Information System (GIS) application (Hayati Nur & Pawenang T, 2021)

Figure 3. Dengue Hemorrhagic Fever Vulnerability Map in Districts/Cities of West Java Province in 2023



Based on Figure 3, the vulnerability level of Dengue Hemorrhagic Fever (DHF) in districts and cities of West Java is described using Incidence Rate (IR) and Case Fatality Rate (CFR). The vulnerability map is categorized into three levels: high risk, medium risk, and low risk. These categories are visualized with three distinct colors: dark blue represents high-risk areas, light blue represents medium-risk areas, and gray represents low-risk areas.

The map identifies high-risk areas as Bogor City, Sukabumi City, Cimahi City, Bandung City, Sumedang Regency, and Cirebon City. Medium-risk areas include Karawang, Bekasi City, Cimahi City, Depok City, Tasikmalaya City, Kuningan, Pangandaran, Purwakarta, and Subang. Low-risk areas consist of Bandung Regency, Bekasi Regency, Bogor Regency, Ciamis, Cianjur, Cirebon Regency, Garut, Indramayu, Banjar City, Majalengka, Sukabumi Regency, and Tasikmalaya Regency. The distribution shows that 6 regions (22.22%) fall into the high-risk category, 9 regions (33.33%) are medium-risk, and 12 regions (44.44%) are low-risk.

The map highlights that urban-based areas dominate new case findings in 2023, emphasizing the need for policymakers to prioritize these regions when implementing strategic measures to combat DHF in West Java Province. Additionally, the map provides an accessible visual tool for students and stakeholders to understand DHF vulnerability. The data visualization simplifies interpretation, making it easier for readers to comprehend the spatial distribution of disease risk within specific regions.

DISCUSSION

The spatial analysis of Dengue Hemorrhagic Fever (DHF) in West Java Province revealed significant differences in vulnerability levels across districts and cities. The high-risk areas, predominantly urban regions such as Bogor City, Bandung City, and Cimahi City, exhibited elevated Incidence Rate (IR) and Case Fatality Rate (CFR). This trend is strongly associated with high population density, rapid urbanization, inadequate vector control, and poor waste management. emphasized that densely populated urban centers with limited infrastructure for vector control provide optimal breeding conditions for *Aedes aegypti*, which thrives in stagnant water sources and household containers commonly found in urban settings (Astuti et al., 2022)

A comparative study in Bangkok, Thailand, (Cummings et al.,)reported that rapid urbanization and climate change contributed to prolonged mosquito breeding seasons, thereby increasing dengue transmission rates .These parallels indicate that urban environmental factors significantly amplify dengue vulnerability, reinforcing the need for integrated urban planning and mosquito control measures (Latifah & Fitria, 2021).

The overlay of IR and CFR maps in this study enabled a comprehensive identification of high-risk areas, emphasizing the importance of Geographic Information Systems (GIS) in public health surveillance. Previous research in Klaten also demonstrated how GIS-based dengue risk mapping improved outbreak preparedness and targeted intervention strategies (Astuti et al., 2022)However, differences in risk levels across districts highlight the need for localized dengue prevention strategies, taking into account socioeconomic factors, climate variability, healthcare accessibility, and public health policies.

While urban centers report higher morbidity rates, variations in CFR across districts suggest disparities in healthcare access, early diagnosis, and treatment availability. Areas with low CFR, such as Sukabumi and Tasikmalaya, likely benefit from better access to healthcare facilities and early case management, leading to lower fatality rates. In contrast, districts with high CFR may face challenges such as delayed diagnosis, underreporting of cases, and limited hospital capacity, which worsen disease outcomes. Reported that delayed medical intervention significantly increases dengue severity and mortality, underscoring the need for early detection systems and improved healthcare infrastructure (Centers for Disease Control and Prevention, 2024)

Additionally, public awareness and community participation play a crucial role in DHF prevention. Studies in Vietnam and the Philippines showed that community-driven mosquito control programs such as regular environmental cleanup and the use of larvicide-treated containers led to a notable decline in DHF incidence (Nguyen-Tien et al., 2022). This highlights the importance of educational campaigns and proactive vector control efforts in reducing disease transmission(Guad et al., 2021)

This study has some limitations that must be acknowledged. First, the validity and completeness of DHF case reporting at the district/city level may be affected by differences in surveillance capacity. Underreporting or misclassification of cases could influence the accuracy of risk mapping. Second, the study did not account for climate variables such as rainfall and temperature, which are known to influence mosquito breeding and dengue transmission. Future research should consider integrating meteorological data and machine learning models to improve predictive accuracy in dengue risk mapping.

CONCLUSIONS AND RECOMMENDATIONS

This study demonstrates that utilizing Geographic Information Systems (GIS) in health data analysis provides a comprehensive understanding of disease distribution patterns. In the case of Dengue Hemorrhagic Fever (DHF) in West Java Province in 2023, high-vulnerability areas were predominantly located in urban regions. These findings highlight the need for greater attention to densely populated and highly urbanized areas to mitigate the risk of disease transmission. To effectively reduce dengue incidence, policymakers should implement integrated mosquito eradication programs, such as routine fogging in high-risk areas, community-driven larval source reduction campaigns, and stricter regulations on water storage management to eliminate breeding sites. Additionally, public awareness campaigns should be intensified through schools, local health centers, and digital platforms to educate communities on early dengue detection and vector control. Strengthening health facilities in high-risk districts, particularly by enhancing diagnostic capabilities, ensuring adequate hospital bed availability, and improving referral systems, is also critical in reducing mortality rates. GIS-based spatial analysis offers added value by simplifying complex health information into map visualizations that are easily understood by various stakeholders, including policymakers and educators. This accessibility enhances the ability to identify priority areas and design targeted interventions for disease control and prevention. The results of this study are expected to support more informed decision-making processes for risk mitigation efforts in the future, emphasizing the importance of integrating spatial analysis into public health planning, vector control strategies, and resource allocation to build a more resilient healthcare response to dengue.

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