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Mapping the spread of dengue hemorrhagic fever (DHF) with the level of insecurity in Kepahiang Regency in 2021

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Abstract

Purpose: This study aims to map the distribution of dengue cases in Kepahiang Regency based on the distribution of dengue cases, population density, and air temperature. Furthermore, mapping was carried out based on the level of vulnerability and priority of sub-district-based dengue disease management in Kepahiang Regency. **Method:** Research using a descriptive method using Geographic Information System (GIS) with scoring and overlay techniques. The data was taken from secondary data from the Kepahiang Regency Health Office and Kepahiang Regency Meteorology and Geophysics Agency in 2021. **Results:** This study shows that out of 8 sub-districts, there is one with a high level of vulnerability with priority handling, namely Kepahiang Regency. The priority of dengue insecurity can be an effort to prevent and handle dengue disease by the Government. **Conclusion:** Mapping the level of dengue insecurity in Kepahiang Regency using parameters (dengue cases, population density, and temperature) resulted in 1 in 8 sub-districts being in priority 1 with a high level of insecurity, priority 2 (1 sub-district) with a moderate level of insecurity, priority 3 (1 sub-district) with a low level of insecurity, and priority 4 (5 sub-districts) with a very low level of insecurity.

Keywords: dengue hemorrhagic fever; degree of insecurity; GIS

INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is an infectious disease caused by the Dengue virus and transmitted through mosquito vectors of the species Aedes *aegypti* or *Aedes albopictus* [1]. Dengue cases were first reported in Jakarta and Surabaya in 1968, with 58 cases and 24 deaths (CFR 41.3%). Within 50 years (1968-2017) it succeeded in reducing the mortality rate (CFR) of DHF to less than 1%. In 2017, the national DBD CFR fell to 0.72%. Over the past decade (2008-2017), the incidence (IR) of DHF ranged from 26.1 per 100,000 inhabitants to 78.8 per 100,000 inhabitants [2]. Dengue morbidity is also related to the public's understanding of dengue prevention and needs improvement. Efforts to prevent and control dengue fever aim to reduce cases / IR and mortality / CFR. The national target is < 49 IR DBD and IR per 100,000 population [2]. Four dengue virus serotypes are endemic to Indonesia: Den1, Den2, Den3, and, Den4.

The dominant serotype in Indonesia is Den3 (50.08%), followed by Den1 (20.7%). In the 2019 dengue fever, 138,127 cases were reported, and up to 919 deaths from DHF (IR = 51.48, CFR = 0.67% per 100,000 population). Currently (as of August 19, 2020), 34 provinces are exposed to dengue fever, and 470 regencies/cities are infected with dengue fever from 514 regencies/cities throughout Indonesia. In 2021, there were 73,518 dengue cases in Indonesia. This number decreased by 32.12% compared to the previous year, 108,303 cases, with an average of 27 cases per

100,000 population infected with dengue fever [1]. Based on data from the Kepahiang Regency Health Office, Kepahiang Regency is one of the dengue fever-prone areas. The number of dengue cases reported in 2021 was 86, with an incidence rate of 60.7 per 100,000 population [3].

DHF is a disease that can threaten public health, so it needs to be prevented from spreading. Factors of mobility and population density, temperature, and humidity of the air can cause dengue transmission. Increasing population density will increase the chances of spreading dengue cases so that it can be carried out by mapping [4,5]. Complex data management requires an integrated information system to process spatial and non-spatial data effectively and efficiently. Geographic Information Systems (GIS) can be used as a solution to these problems [5,6].

Furthermore, the information obtained is in the form of geographical information. Geographic Information Systems (GIS) can visualize data and modify shapes, colors, and symbols, providing beneficial convenience in the health field [5]. GIS is a tool to monitor the condition of an area for the incidence of dengue disease. GIS will provide final results in maps that facilitate identifying and searching dengue-prone areas in Kepahiang Regency [4]. To support the implementation of dengue eradication programs, mapping can use the creation of area models against diseases using overlay analysis. Analysis overlays can generate a spatial model by applying a score [7].

Previous research was conducted in South Minahasa which carried out mapping of dengue fever based on cases presented in the map and then related to the number and density of the population descriptively without presenting dengue fever's factor by map [5]. Research on mapping dengue cases was also carried out in Aceh Regency with dengue cases, and mosquito density with GIS in the work area of one of the health centers, namely the Lhoknga District Health Center, then the handling of the spread of dengue cases was carried out only based on mosquito density, while dengue transmission could be caused by several other factors such as population density and temperature [6]. Another dengue fever research by mapping conducted in the city of Padang using overlay analysis explained that the overlay technique is an analysis that overlaps two or more variables to produce intervariable relationships that can be presented in one map [8].

The spread of dengue cases in Kepahiang Regency is still being processed manually, and there has been no assessment of the spread of dengue cases based on geography. Using GIS will be able to facilitate information that will provide a priority scale determination for the government and help the dengue eradication program by determining priority areas for handling dengue disease in Kepahiang Regency. For this reason, this study aims to map the spread of dengue disease (spread of dengue cases, population density, and temperature) using GIS.

METHODS

The research method is carried out descriptively which will describe the incidence of dengue hemorrhagic fever (DHF) in the Kepahiang Regency Puskesmas Working Area in 2021. The data used comes from secondary data in 2021 from the Kepahiang Regency Health Office (the number of dengue cases and the population density of each sub-district) and the Kepahiang Regency Meteorology and Geophysics Agency (air temperature). The analysis will use administrative units of Kepahiang Regency based on sub-districts, as many as eight sub-districts that will be processed using QGIS devices.

The research phase will begin with collecting secondary data, creating data classification, and inputting variable attributes (dengue cases, population density, and air temperature). The data were analyzed using scoring and overlay techniques. The scoring technique in GIS is the process of assigning scores to a polygon map that presents a specific event in the spatial analysis stage, which in turn, the assessment will present the degree of interrelation or severity of a certain impact on the event spatially. While the overlay technique in GIS comes from combining maps with specific information.

The DHF case and temperature parameters refer to previous studies with [8], then density classification based on to find the score range with the following formula [9] :

$$z = \frac{x-y}{k}$$

Information:
z = Hose class/category width
x = Highest score value
y = Score value
k = Number of category classes

Then the three variable scores are summed up to determine the classification of dengue insecurity levels. The classification results obtained are a total score of 10-12 (high vulnerability level), a score of 8-9 (medium vulnerability level), a score of 6-7 (low vulnerability level), and a score of 3-5 (very low insecurity level). Districts with high levels of vulnerability will be priority areas for dengue fever.

RESULTS

Kepahiang Regency is a district in Bengkulu Province which is geographically located between 101°55'19" to 103°01'29" east longitude (BT) and 02°43'07" to 03°46'48" South Latitude (LS). Kepahiang Regency has an area of approximately 66,500 hectares or 665 km^2. Kepahiang Regency has eight districts: Merigi, Ujan Mas, Kepahiang, Tebat Karai, Seberang Musi, Kabawetan, Muara Kemumu, and Bermani Ilir Districts [3].

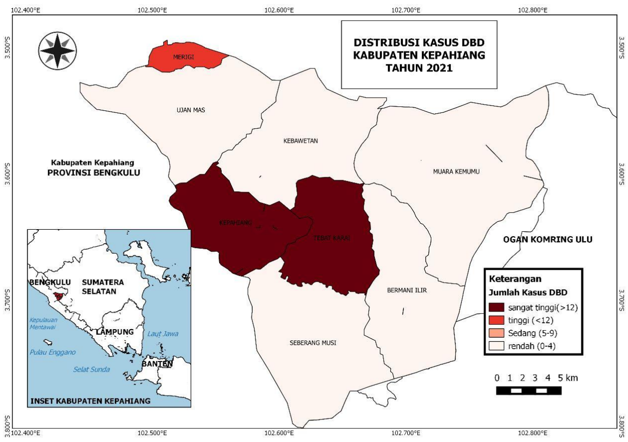

Figure 1. Map of the distribution of dengue cases in Kepahiang Regency in 2021

Figure 1 explains the spread and the number of dengue cases in Kepahiang Regency in 2021 was 86. Classified into four categories (low, medium, high, and very high). The spread of dengue cases is very high (>12 cases) in 2 sub-districts, namely Kepahiang and Tebat Karai Districts marked with dark green. The high category (10-12 cases) occurred in 1 sub-district, namely Merigi District. Then there is no spread of moderate category DHF cases because there are no sub-districts that have a total of 5-9 cases, and the low category (=<4 cases) occurs in 5 districts, namely Ujan Mas, Seberang Musi, Kabawetan, Muara Kemumu, and Bermani Ilir Districts. Spatially, very high cases are seen close to each other.

Figure 2 explains the population density of Kepahiang Regency in 2021 by sub-district. The population density classification is categorized into four categories (low, medium, high, and very high). Districts with high categories (>3.7 people/km^2) are in Kepahiang and Merigi Districts, there are no sub-districts in the high category because the population density is not 2.5-3.6 people/km^2. Furthermore, the medium category (1.3-2.4 people/km^2) in districts of Ujan Mas, Tebat Karai, Kabawetan, Muara Kemumu, and the low category (0-1.2 people/km^2) in

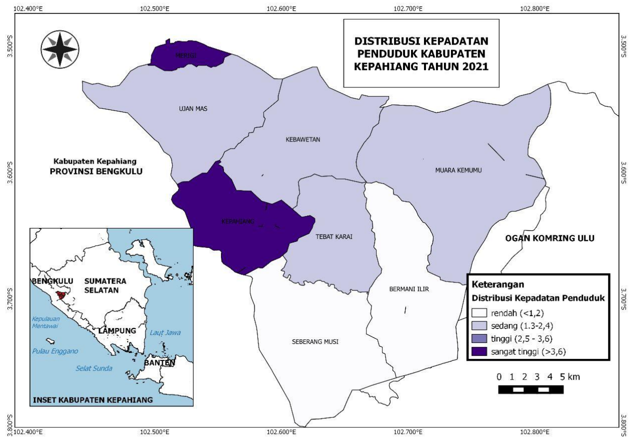

Figure 2. Map of dengue density distribution in Kepahiang Regency in 2021

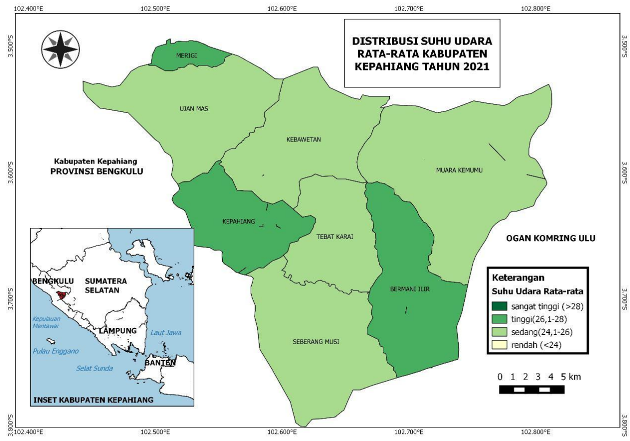

Figure 3. Map of the average temperature distribution of dengue fever in Kepahiang Regency in 2021

Seberang Musi and Bermani Ilir Districts. Regarding space, the population density is located above and in the middle of Kepahiang Regency.

Figure 3 explains the distribution of average air temperatures in 2021 of each sub-district is classified into four categories (low, medium, high, and very high). The darker the color indicates the higher the temperature in the district. On the map, it is known that districts with very high average air temperatures (>28^{0}C) do not exist. Then in the high-temperature category (26.1-28^{0}C), there are three districts, namely Kepahiang, Merigi, and Bermani Ilir districts, the medium-temperature category (24.1-26^{0}C), there are five districts, and in the low-temperature category (< 24^{0}C) there are none. This shows that the air temperature varies in each sub-district even though it is in 1 sub-district. The spatial map shows that the districts with high temperatures are in the middle, top, and bottom of the Kepahiang Regency area. Overall they are seen to have moderate to high temperatures.

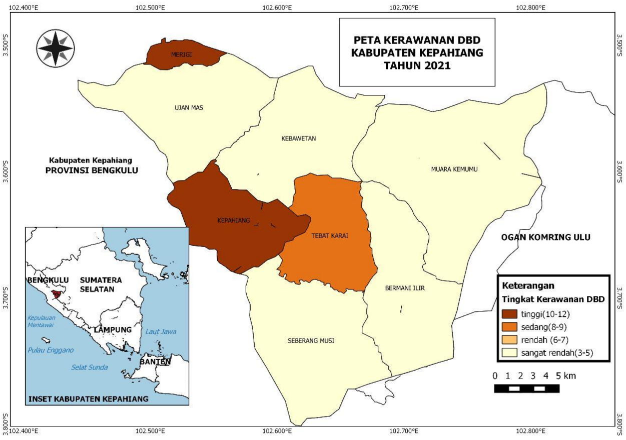

Figure 4. Dengue insecurity level map of Kepahiang Regency in 2021

Based on the level of dengue insecurity from 8 sub-districts, sub-districts that have a darker color, namely Kepahiang and Merigi Regencies, are high levels of vulnerability. The level of insecurity is in Tebat Karai district, there are no sub-districts at a low level of insecurity, and there are five sub-districts at a very low level of insecurity (Seberang Musi, Bermani Ilir, Muara Kemumu, Kabawetan, and Ujan Mas districts).

The data processing results use the Geographic Information System, with assessment techniques and *variable overlays* (dengue cases, population density, air temperature) to determine priority areas for dengue fever management.

Table 1. Priority area table for DBD handling

Number	District	Priority areas
1	Kepahiang	High (10-12)
2	Ujan mas	Very low(3-5)
3	Merigi	High (10-12)
4	Kabawetan	Very low(3-5)
5	Across the musi	Very low(3-5)
6	Tebat karai	Medium(8-9)
7	Bermani ilir	Very low(3-5)
8	Mumu Estuary	Very low(3-5)

DISCUSSION

The incidence of DHF can be caused by several factors such as the virus that causes DHF, humans, mosquito vectors, and the environment. Population density is one of the causes of the human factor because the increasing population growth not supported by behaviors and lifestyles to maintain environmental cleanliness will increase the spread of dengue cases [10]. This study is in line with research in Padang in 2022 which states that the denser the population of an area, the higher the likelihood that mosquito bites and dengue transmission will spread rapidly in an area [8]. The theory and results of previous research align with the research results on the spread of dengue cases that occurred in Kepahiang Regency with high and medium-density categories. The district with a high-density category is Kepahiang Regency.

Several studies have found a strong correlation between high-risk areas for dengue infection and dense urban areas. Environmental and social factors from some regions seem to influence the incidence of dengue fever. High population density allows for rapid urbanization and intensive mobility that can support the distribution of the virus and increase the likelihood of contact between DHF vectors and humans [11]. Due to the lack of proper water infrastructure, dense human settlements can offer lucrative breeding opportunities for mosquitoes using containers filled with natural and artificial water to lay eggs [12]. Environmental degradation, urban land expansion, and poor sanitary conditions facilitate favorable conditions for parasitic infections, which can increase the risk of dengue outbreaks in the region. In addition, the habit of storing water for domestic purposes at home due to the lack of water supply, especially during the dry season, increases the likelihood of mosquitoes laying eggs and the spread of mosquitoes from house to house, leading to an excess of the dengue virus [13]. The high population density causes a narrow air scope and is suitable as a breeding ground for *Aedes Aegypti* mosquitoes. Aedes Aegypti mosquitoes love human blood, and the Kepahiang subdistrict is a high-density district, which is why the Kepahiang subdistrict is at priority level 1.

The incidence of dengue based on temperature is stated in the results of a study in Cimahy City which states that the average temperature in Cimahi City is 24,34 ^{0}C. This temperature is in accordance with the optimum temperature of mosquito development which according to WHO is between 25-27°C [14]. Temperature reduction affects the survival of adult mosquitoes so it will affect the transmission of the dengue virus, and will affect mosquito bite and reproduction patterns, and increase mosquito population density. The theory and results of previous research align with the research results on the spread of dengue cases that occur in the Kepahiang district with high and moderate air temperatures. Kepahiang Regency generally consists of highlands and has a mild climate with a high average air temperature category. However, moderate temperature points of dengue infection were identified in 5 sub-districts, including Ujan Mas, Muara Kemumu, Kabawetan, Tebat Karai, and Seberang Musi. Similar findings were reported in Sri Lanka that the distribution of dengue vectors appears limited by altitude. Unlike in Sri Lanka, the specific factors underlying the conditions in Kepahiang District are unclear but can be affected by the prevention and control of dengue fever by those carried out by the Health Office [15].

Kepahiang Regency in 2021 has two districts that have a high level of dengue insecurity, namely Kepahiang and Merigi Districts, at a moderate vulnerability level with priority 2, namely Tebat Karai district, then priority 3 in 5 districts, namely Kabawetan, Bermani Ilir, Ujan Mas, Muara Kemumu and Seberang Musi. High population density and high temperatures lead to a large number of dengue cases, with district prioritization prevention efforts can be focused on areas with high levels of insecurity.

Mapping done with GIS can help prevent the spread of disease if dengue cases reappear. Wisnu Irawan as the Head of Disease Prevention and Control (P2P), the Kepahiang community is still haunted by dengue fever in the winter due to many puddle containers [16]. Prevention efforts can be carried out with the cooperation of the government and community participation by providing counseling and environmental interventions. Counseling efforts are carried out regarding dengue fever by instilling messages and beliefs about the dangers of dengue fever, and how to prevent and overcome it [17]. Furthermore, environmental interventions by the community to be able to carry out prevention by applying 3M (Draining, Closing, and Burying), maintaining the cleanliness of the environment, food, and beverages, as well as it is recommended using mosquito nets or put on mosquito repellents. This is due to the low awareness of a healthy lifestyle and cleaning the living environment (15). Meanwhile, the government can help provide larvicides (abate) in all water reservoirs to inhibit the growth of *Aedes spp* larvae [18].

Consideration of the use of mapping in the government depends on its usefulness, such as identifying areas lacking health workers, allocating medicines, searching for health facilities, and mapping infectious diseases. Mapping is basically used for visualization and descriptive purpose, but the use of GIS and spatial analysis can then be used as a decision-making tool for the government in handling health problems [17].

CONCLUSION

This study concluded that mapping the level of dengue disease in Kepahiang Regency using parameters (dengue cases, population density, and air temperature in 2021) showed from 8 to sub-districts, namely at the level of dengue insecurity priority 1 (2 to sub-district), priority 2 (1 sub-district), and priority 3 (5 sub-districts). The spread of dengue cases has a variety of factors, such as population density and the environment. Regional mapping using geographic information systems can help visualize dengue disease insecurity level data displayed in the form of symbols and colors to assist the government in targeting prevention efforts against areas with a high priority level to reduce the spread of dengue cases.

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