Mapping The Distribution of Dengue Cases Using GIS In Banjarnegara Regency 2017-2022

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Abstract. Dengue fever in Banjarnegara Regency remains a significant public health issue that requires effective control measures. This study employs a Geographical Information System (GIS) to analyze the spatial distribution and socio-cultural indicators associated with dengue cases from 2017 to 2022. This research is descriptive research with Case Series design. The collecting dengue data from the hospital through the KDRS in putting it into the electronic DHF application from 2017-2022. The total sample is 1192 cases, namely dengue cases that have been confirmed using the e-DBD application. Descriptive data analysis in the form of maps, graphs, and tables. The distribution of dengue cases is more common in lowland areas (¡ 700 above sea level) with high population density. Dengue incidence tends to be in the urban, rainy season, male, and from the productive age group (15-44 years). GIS can be used in initial actions to localize the prevention and control of dengue outbreaks in Banjarnegara Regency.

Keywords: dengue mapping, GIS analysis, disease distribution, epidemiological study

1 Introduction

Dengue is an infectious disease caused by the dengue virus and occurs frequently in tropical and sub-tropical areas. This disease is transmitted to humans through the bite of an infective mosquito, primarily the Aedes aegypti mosquito. Other species within the Aedes genus can also act as vectors, but their contribution is secondary to Aedes aegypti [1].

The incidence of dengue has increased significantly throughout the world in recent decades [2]. Bhatt estimates that 390 million dengue infections occur every year and 96 millions of them have clinical manifestations with varying degrees of disease severity [3].

In Indonesia, the 2020-2022 period shows a very fluctuating pattern, which has never happened before. This may be affected by the Covid-19 pandemic situation. Moreover, the initial symptoms of dengue and Covid-19 are similar. By the end of 2022 the number of dengue cases in Indonesia will reach 143,000 cases, with the highest number of dengue cases in the provinces of West Java, East Java and Central Java.

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Nationally, the number of dengue cases is much lower than the estimated number of dengue cases in Indonesia [4]. Bhatt predicts that in Indonesia, the number of symptomatic dengue cases will reach 7,590,213 cases or 50 times higher than the number of cases reported en 2022 [3].

Central Java Province is ranked as the third highest morbidity rate in dengue cases per 100,000 population en 2022. The highest dengue cases in Central Java Province are Grobogan Regency, Sukoharjo and Pati Regency [5].

Banjarnegara Regency is one of the dengue endemic areas in Central Java Province. The incidence of dengue fever in 2022 is 45/100,000 population, an increase compared to 2021 (incidence rate 16.50/100,000 population). The most cases were in Mandiraja and Purwonegoro Districts with 104 cases and 72 cases respectively [6].

The increase and spread of dengue cases is likely caused by high population mobility, urban development, climate change, changes in community behavior, and not yet optimal and sustainable efforts to eradicate mosquito nests, so there needs to be efforts to educate the public to carry out routine preventive actions. The government program targets the National Strategy for the Prevention and Control of Dengue Fever for 2021-2025 to reduce the death rate due to dengue fever to 0 by 2030 [7]. To achieve this target, dengue must be recognized as a collective threat. Global collaborative efforts are needed to strengthen dengue fever preparedness, prevention and control.

Geographical Information Systems (GIS) are components consisting of hardware, software, geographic data, and human resources that work together effectively to enter, store, enhance, update, manage, analyze, and display geographically based information [8, 9]. To manage complex data, an information system is needed that is capable of processing spatial and non-spatial data effectively and efficiently [10].

One effort that can reduce the problems caused by dengue fever cases in Banjarnegara Regency is with a GIS approach. Considering the problems above, the aim of the research is to determine the epidemiological distribution of dengue fever cases based on e-DBD confirmation using the GIS application in Banjarnegara Regency. It is hoped that the Geographic Information System can help predict the incidence of dengue fever in the future, thereby facilitating efforts to control dengue fever.

2 Method

2.1 Studi Area

Astronomically Banjarnegara Regency is located between 7'12"–7'31" South Latitude, 109'20" – 109'45" East Longitude. Area is shaped in landby 106,970.997 Ha or about 3.29% from Jawa Tengah Province area (3.25 million ha). Banjarnegara Regency area is located on mountain path in the middle of west Central Java from West to East. Land use divided into 14,049 Ha of wetland (13.13% from the total area of Banjarnegara) and 72,140 Ha of nonwetland (67.44% from the total area of Banjarnegara). Then non-agriculture land is 20,782 Ha (19.43%). Banjarnegara Regency has tropical climate, rainy season, and dry season after year. Wet moons are generally more than dry months [11]. Banjarnegara Regency has 20 subdistric. These include:

Susukan, Purwareja Klampok, Mandiraja, Purwanegara, Bawang, Banjarnegara, Pagedongan, Sigaluh, Madukara, Banjarmangu, Wanadadi, Rakit, Punggelan, Karangkobar, Pagentan, Pejawaran, Batur, Wanayasa, Kalibening, Pandanarum. (Fig. 1).

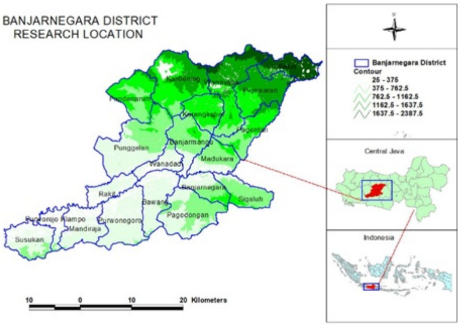

Fig. 1. The Map Of Study On Banjarnegara Regency

2.2 Epidemiology Data

Epidemiological data on dengue fever cases was obtained from the Banjarnegara District Health Service, 2017-2022. The sampling unit in this research is Hospitals, and Inpatient Health Centers for the periode individual households. The samples were all dengue fever patients confirmed by the electronic DHF (e-DHF) application in the study area (1192 cases).

2.3 GIS modelling with geografical data

Spatial data is geographically oriented data, in this case what is included in spatial secondary data is a digital map of Banjarnegara Regency based on village and sub-district areas. The analysis used in this research is spatial analysis, so that a map of the distribution of dengue disease will be produced based on research variables (altitude, population density, endemicity) which are compared with geographical location and limited by village or sub-district areas in Banjarnegara Regency during 2017- 2022.

2.4 Analisys

Descriptive analysis is used to describe the epidemiology of dengue cases (place, time and person) as well as the distribution of dengue cases based on endemicity, altitude, population density and month of variation (dengue incidence and rainfall) in 2017-2022. To obtain the spatial distribution of dengue cases using GIS-based analysis, the number of dengue cases was mapped at a scale of 1:25,000 using GIS techniques in Arc-GIS 9.3 (Demo Version) software.

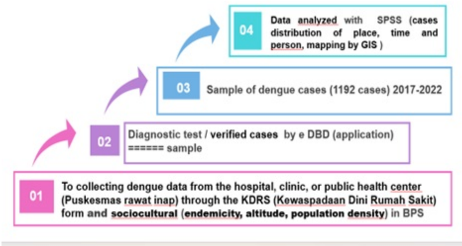

Fig. 2. General Workflow Of Methodology

3 Result and Discussion

Mapping the geographic distribution of dengue cases in an area can show the magnitude of the burden and risk based on conditions, facilities, and available resources. Figure 2 shows the total dengue cases in Banjarnegara Regency from 2017 to 2022 as many as 1192 cases. The highest number of cases occurred in 2019 with 290 cases, while 2017 was the lowest (59 cases). Based on the analysis, it was found that there was a pattern of increasing dengue cases every three years. There was a decrease in cases in 2020 and 2021, but cases increased again in 2022.

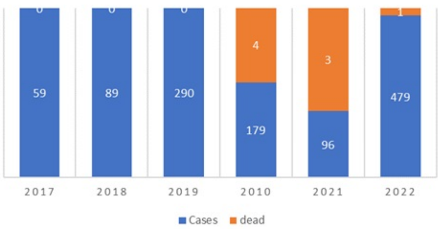

Fig. 3. Dengue cases in Banjarnegara Regency from 2017-2022

Dengue cases in Banjarnegara Regency during the 2017-2022 period were spread across 200 villages out of 278 existing villages, with 158 villages categorized as low endemic (1-9 cases), 32 villages with moderate endemic (10-19 cases), and high endemic (10-19 cases). 20-33 cases) there are 10 villages, and 78 villages are free (0 cases). All dengue cases are spread shown in Fig 3. The incidence of dengue in Banjarnegara Regency in 2022 has increased (IR=46/100,000 population) when compared to 2021 (IR=9/100,000 population), and there are indications that it continues to be found throughout the year with the pattern being dominant in urban areas.

Figure 4 shows the distribution of dengue cases from 2017-2022. By looking at the existing data, so far urban areas, namely Banjarnegara sub-district, have had many

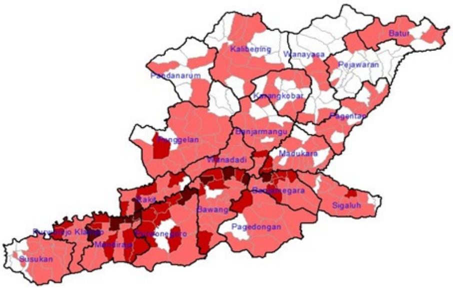

Fig. 4. Distribution of dengue cases in Banjarnegara Regency 2017-2022

cases, but in recent years the largest number of cases have shifted to the urban outskirts, namely Bawang, Purwonegoro and Mandiraja sub-districts which are along the national road. In 2022, there will still be 1 death due to dengue in Mandiraja sub-district. This is less than in 2021 with 3 cases of death with the distribution in Susukan sub-district 1 case, Purwanegara 1 case, and Wanadadi 1 case (fig. 2)

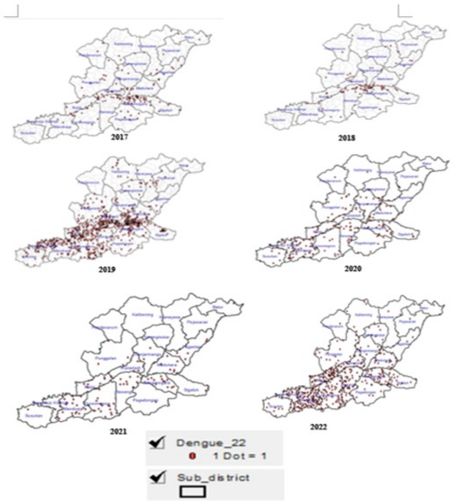

Fig. 5. Spatial Distribution of Dengue cases in Banjarnegara Regency from 2017- 2022

Population density of the 2022 population is 971 people per km2, which means that every 1 km2 of Banjarnegara Regency is occupied by about 971 people [11]. Based on Figure 5, the proportion of population density in Banjarnegara Regency in 2022, there are nine sub-district areas with a population density proportion above 1,000 people/km2, namely the Susukan sub-district, Purworejo Klampok sub-district, Mandiraja sub-district, Purwanegara sub-district, Bawang sub-district, Banjarnegara sub-district,

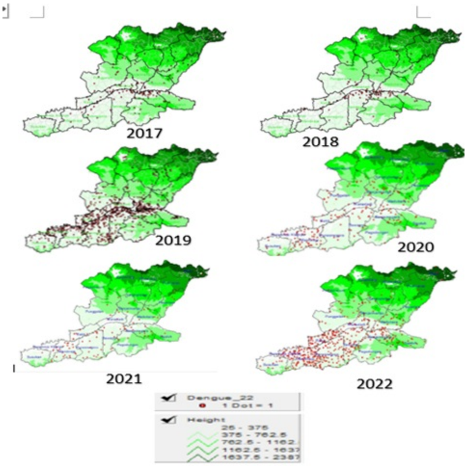

Fig. 6. Spatial Distribution of Dengue cases and Altitude in Banjarnegara Regency from 2017-2022

Banjarmangu sub-district, Wanadadi District and Rakit District. Meanwhile, 11 other regions have a population density proportion below 1,000 people/km2. Based on the analysis of dengue cases from the 2022 DBD electron program, the highest frequency of dengue cases is in the Mandiraja District area, namely 21.7%. Mandiraja District is an area with a population density of more than 1,000 people/Km2, so the pattern of dengue distribution based on population density tends to move in a positive direction, meaning that areas with a high proportion of population density show a high incidence of dengue as well (Fig 5)

The research results show that during 2017-2022 dengue cases occurred equally in women (49.5%) and men (50.5%) as well as cases of death due to dengue (figure 8). Data shows that dengue cases attack all age groups ¡1, 1-4, 5-14, 15-44, and over 44 years (Figure 7). However, the 15–44-year age group has been most affected over the last six years. Meanwhile, deaths due to dengue occur more frequently in the 5–14-year age group.

The average rainfall index in Banjarnegara Regency is 12.12 mm/Hg and the incidence of dengue cases tends to increase if rainfall levels are high. The rainy season occurs throughout the month more than the dry season. The highest rainfall occurs in November, December and January, while the dry season occurs in June, July August (Fig.9)

Dengue cases can be found in almost all villages in Banjarnegara district. However, in general the incidence of dengue is highest in urban areas with high population density. Figure 3 shows that most parts of Banjarnegara regency have low endemicity for dengue. Areas that are included in the low endemic category are those that have a few cases ¡ 9 in the period 2017-2022 and are quite spread out across the area. Although the low number of cases can reflect the actual conditions in the area, there is also the possibility that the low number of cases reflects obstacles in detecting cases due to in-

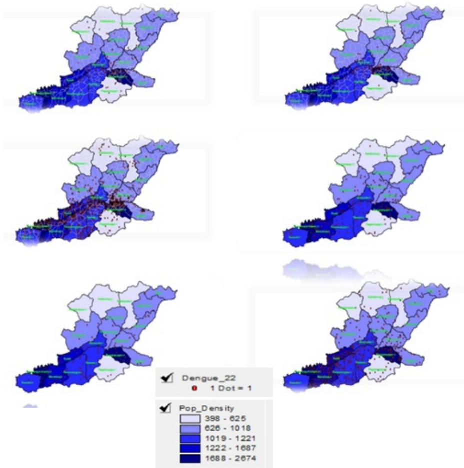

Fig. 7. Spatial Distribution of Dengue cases and Population Density in Banjarnegara Regency from 2017- 2022

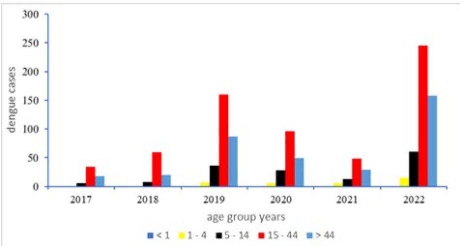

Fig. 8. Dengue Cases Based on Age in Banjarnegara Regency from 2017-2022

adequate diagnostic facilities and a weak surveillance system resulting in obstacles in reporting dengue cases. what happened (underreporting).

The expansion of the distribution of dengue cases is expected to increase due to factors such as climate change, globalization, tourist travel, trade, socioeconomics, housing, and the evolution of the virus [12].

This strategy includes increasing the capacity and quality of dengue services in primary health facilities (Puskesmas) and hospitals, both in government and private health facilities by increasing the accuracy of dengue case referrals, improving the quality of diagnosis and treatment of dengue cases, increasing the availability and competencies of dengue cases. clinical health workers in implementing dengue management guidelines in health facilities, as well as increasing the capacity and compliance of health workers in reporting cases.

Various efforts have been made by the dengue program manager at the Banjarnegara District Health Service to reduce transmission and control dengue cases. If there is a suspected case of dengue fever, it can be responded immediately by verifying the

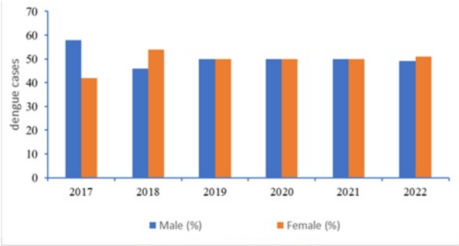

Fig. 9. Gender-wise distribution of Dengue Cases in Banjarnegara Regency from 2017-2022

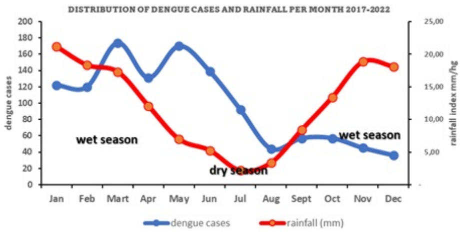

Fig. 10. Dengue Cases and Rainfall Per Month 2017-2022

case and then if it meets the fogging criteria, this action will be taken immediately. Another role carried out by the Fogger Team is helping in monitoring Aedes aegypti mosquito larvae when there are no cases or after there are cases. This assistance is carried out both in the community, at schools and in agencies, especially for areas with a history of dengue cases and deaths. Other mandatory activities in each case area include community education about controlling dengue fever and the formation of Jumantik cadres. Movement of one house, one larva monitors to control the spread of dengue vectors. Handling and treatment of sufferers is carried out in health facilities according to the severity of the dengue patient. If you need a referral, you will be referred to a more complete health facility.

Naturally, gender does not influence the incidence of dengue, but rather due to coincidence or chance [13]. This theory is in accordance with the research results. In this study, if we look at it spatially for areas that are included in free, low endemic, moderately endemic and high endemic areas, it is known that the gender proportion of the population in Banjarnegara Regency is based on sub-district areas in the last six years. There are almost the same proportions between men and women, so that in this study the gender variable shows that the pattern of disease distribution tends to move in a negative direction in theory, it is believed that women are more at risk of being infected a disease caused by dengue virus, thus obtaining more severe clinical manifestations than men. This is based on the assumption that capillary walls in women are more likely to increase capillary permeability compared to men [14].

According to Novikasari, there is a significant relationship between age and gender on the incidence of dengue hemorrhagic fever [15]. In this study, it was found that those aged ¡15 years were more at risk of contracting dengue hemorrhagic fever, this is because children have a more vulnerable immune system than children. with adults. There has been a shift from a dengue epidemic that was originally in children to more cases in adults [16, 17]. Research in Taiwan showed that of 136 respondents, the majority of dengue cases occurred in adults and only five cases occurred in children or adolescents under 18 years [18]. However, research conducted in Sao Luís, Maranhao, Brazil stated that age has a significant relationship with dengue cases and attacks most children aged ¡15 years [19].

Then the male gender is more at risk of contracting dengue hemorrhagic fever because men tend to be active outside the home more often in the morning and evening, besides that, cytokine production in women is greater than in men, so women's immune system is better. from men [15].

Population density is also closely related to the incidence of dengue and has a positive pattern, meaning that the denser the population, the easier it is for mosquito vectors to transmit dengue hemorrhagic fever [20]. Densely populated urban areas are known to have houses that are close together, thus allowing the transmission of the dengue virus by the Aedes aegypti mosquito vector which has a relatively short flight distance, estimated at around 106 m [21]. Population density results in dense settlements so that dengue disease spreads more quickly. Population growth that does not have a certain pattern causes the emergence of slum areas with poor infrastructure and sanitation systems, resulting in breeding sites for mosquitoes. Population density will facilitate the transmission of dengue virus due to the multiple bitting nature of the virus. Population density is correlated with mosquito flying distances and dengue disease transmission [22].

Rainfall is an important climate element in vector density because if the rainfall is high, it can cause standing water which has the potential to become a breeding site for the Aedes aegepty mosquito [23]. Rainfall affects the population density of adult female mosquitoes. High rainfall can cause the formation of breeding sites for mosquitoes, thereby increasing the mosquito population. Usually in tropical countries, dengue cases increase during the rainy season and decrease several months after the end of the rainy season.

4 Conclusion

Dengue cases were spread in almost all vilages in Banjarnegara with most cases of dengue fever come from the productive age group. The distribution of dengue cases is more common in lowland areas (¡ 700 above sea level) with high population density, in the urban, and rainy season.

This visualization approach (GIS) helps the public health officials to identify the zones of disease endemics in executing real-time decisions for preventive and precautionary strategies to control the prevalence of dengue disease effectively in Banjarnegara Regency. It is hoped that further research will add environmental factors, risky community behavior and predictors of dengue incidents to prevent an increase in dengue cases in the future.

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