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VULNERABILITY MAPPING OF DENGUE HEMORRHAGIC FEVER (DHF) CASES IN WEST JAVA PROVINCE IN 2023

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ABSTRACT
Dengue Hemorrhagic Fever (DHF) is one of the public health problems that needs serious attention, because this disease contributes a high mortality rate. Dengue disease related to environmental conditions, climate, population density, and community behavior. West Java is the highest province of dengue cases in Indonesia in 2023 that has 19,328 cases with the number of deaths due to dengue reaching 134 people. This study aims to map the spread of the disease by describing the distribution of dengue cases and describing the level of vulnerability through risk factors from dengue. The method used in this study is descriptive research with a Geographic Information System (GIS) approach. The data used is secondary data from the official website of the Central Statistics Agency (BPS) of West Java Province. Data analysis was carried out using QuantumGIS (QGIS) version 3.40.4 which is open-source software. The scoring results of 27 districts and cities in West Java Province show that the priority areas in handling of dengue cases are Bogor City, Bekasi City, and Bogor Regency which are the areas with the highest level of vulnerability. This study is expected to provide an overview of the distribution of cases and the level of dengue vulnerability based on districts/cities in West Java Province, so that studies can be carried out on dengue disease prevention and control programs, especially in areas with the highest level of vulnerability.

Keywords: dengue hemorrhagic fever (DHF); geographic information system (GIS); west java

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INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is a disease caused by dengue virus infection which is transmitted through the bite of mosquitoes of the genus Aedes, especially the Aedes aegypti type. Tropical and subtropical climates are countries at high risk of dengue virus transmission. This is associated with high temperature increases and seasonal changes which are one of the risk factors for dengue virus transmission (Saputri, 2019). Dengue disease can appear throughout the year and affect all age groups, both men and women (Profile of the West Java Provincial Health Office, 2023). Dengue is an acute viral infection characterized by fever for two to seven days accompanied by bleeding spots, nosebleeds, bleeding gums, vomiting blood, bloody bowel movements, and decreased platelets (<100,000/mm^3). Other symptoms that can be felt are headaches, muscle and bone pain, skin rashes, and pain behind the eyeballs (Ministry of Health of the Republic of Indonesia, 2017). The incubation period of dengue virus in humans body ranges from three to 14 days before symptoms appear and clinical symptoms appear on the fourth to seventh day (Candra, 2010).

In 2021, WHO estimates that there will be 100 to 400 million dengue infections that occur every year globally (World Health Organization, 2023). In Indonesia, dengue is a serious threat, especially during the rainy season. According to the annual dengue report data published by the Directorate General of Disease Prevention and Control (P2P) of the Ministry of Health, throughout 2022 there were more than 70,000 dengue cases with a death rate of 661 people, and most dengue cases found in West Java, East Java, and Central Java. Based on the Minister of Health Regulation Number 13 of 2022, one of the indicators of the Strategic

Plan for 2020-2024 is the percentage of districts and cities that have a dengue Incidence Rate (IR) of ⩽10 per 100,000 population. According to report data published by the Directorate General of Disease Prevention and Control (P2P) of the Ministry of Health, West Java is the second province that has not reached the national target for DHF IR ⩽10 per 100,000 population in 2023 with an achievement only 7.41% of the national target of 85% (Indonesian Health Profile, 2023). The number of dengue patients in West Java Province in 2023 has 19,328 cases, this was decreases compared to the previous year with total of 36,608 cases. The number of dengue death in 2023 reached up to 134 people with a CFR of 0.69%, this figure decreased from the previous year which was 0.83% (West Java Health Office, 2023). West Java Province has three districts and cities with the highest dengue case, Bogor Regency with 1,881 cases, Bandung City with 1,856 cases, and Bogor City with 1,474 cases (West Java Health Office, 2023).

Many factors affect the spread of dengue cases in an area, including human factors (host), mosquitoes (vector), dengue virus (agent), and the environment. Epidemiologically, dengue transmission involves interaction between mosquitoes as vectors of virus carriers and humans through the environment as a medium of interaction. The spread of dengue fever easily occurs through mosquitoes that can spread to different areas, so dengue cases can spread quickly and tend to increase. Therefore, it is necessary to conduct an analysis to evaluate the factors that influence the spread of dengue. From the factors of geographical conditions that affect the incidence of dengue are physical environmental factors, social environment, and biological environment. Factors that spread of the dengue virus from the physical environment include climatic factors (temperature, humidity, rainfall) (Fitriana, 2019) and physical factors of the house (intensity of sun entering the house, ventilation, and distance between houses) (Puji et al., 2018). The distance between house has been shown to affect the spread of mosquitoes from one house to another, the closer the distance between houses, the easier it will be for mosquitoes to spread in the community (Anggraini et al., 2021). In addition, the social environment is also related to human daily activities, such as education, employment, amount of income, and other activities that interacts with neighbours also be the cause of the spread of dengue virus.

Previous research by Mubarak and Budiantara (2012) found that the factors of the percentage of poor population, population density, percentage of human development index, percentage of health facilities, and percentage of health complaints are factors that affect dengue cases. Research conducted by Hendriana (2022) states that the percentage of households with proper sanitation, the percentage of proper drinking water, and the percentage of public places that meet health requirements are the factors that are significantly related to dengue cases. Disease occurrence can be associated with various objects that include spatial phenomena. To support spatial analysis with disease occurrence, Geographic Information Systems (GIS) can be used to determine the distribution of various regions that have a risk of a disease and determine priority areas with high vulnerability (Achmadi, 2014). Based on various existing problems, the purpose of this study is to map the distribution of the disease by describing the distribution of dengue fever cases and mapping the level of vulnerability through dengue fever risk factors. It is hoped that this study can provide an initial picture of priority areas for health interventions for dengue fever cases in West Java Province.

METHOD

This research was conducted in West Java Province using secondary data in 2023. The administrative area of West Java Province consists of 18 districts and 9 cities. This study uses unit analysis based on the district and city area. The data sources in the study used secondary data obtained from the official website (open data access) of the Central Statistics Agency (BPS) in the form of data on the number of dengue cases in West Java, population density

data, the percentage of households with proper sanitation, and the percentage of the poor population. This study is descriptive quantitative research based on Geographic Information System (GIS) which aims to map the level of vulnerability to dengue incidence in West Java Province in 2023 based on predetermined variables, namely population density, area height, percentage of households with proper sanitation, and percentage of poor population. The research is carried out in several stages, which begin with collecting secondary data, making data classifications and making variable inputs that will be studied in visual form. The data is then analysed using scoring technique. The scoring technique is an analysis technique by assigning a value to each variable, so that the value can be calculated and the level can be determined. Data processing and analysis uses QuantumGIS (QGIS) software version 3.40.4 which is open-source software. The presentation of data in the form of distribution maps and vulnerability maps with analysis units based on districts and cities in the Province of West Java. The distribution map is classified into four categories namely low, medium, high, and very high (Table 1).

Table 1.
Classification Table for Mapping Dengue Cases, Population Density, Area Height, Percentage of Families with Proper Sanitation, Percentage of Poor Population

Variable	Classification			
	Low	Medium	High	Very High
Dengue Cases	≤470	471-940	941-1410	>1410
Population Density	≤3855	3856-7710	7711-1156	>11565
Altitude of the Region	≤198	199-396	397-594	>594
Percentage of Families with Proper Sanitation	≤25%	26-50%	51-75%	>75%
Percentage of Poor Population	≤3%	4-6%	7-9%	>9%

Vulnerability level analysis was done using the scoring method by assigning a score from 1 to 3 to each variable and assigning priority areas based on the highest number of scores. The presentation of vulnerability levels is divided into three categories, low vulnerability, medium vulnerability, and high vulnerability (Table 2).

Table 2.
Variable Scoring Table of Dengue Cases, Population Density, Area Height, Percentage of Families with Proper Sanitation, Percentage of Poor Population

Variable	Score		
	Low	Keep	Tall
Dengue Cases	1	2	3
Population Density	1	2	3
Altitude of the Region	3	2	1
Percentage of Families with Proper Sanitation	3	2	1
Percentage of Poor Population	1	2	3

RESULT

The presentation of maps in this study is visualized by color gradation, where color determination is based on the score obtained for each region in each research variable. Darker colors indicate a higher level of score.

Distribution of Dengue Cases in West Java Province in 2023

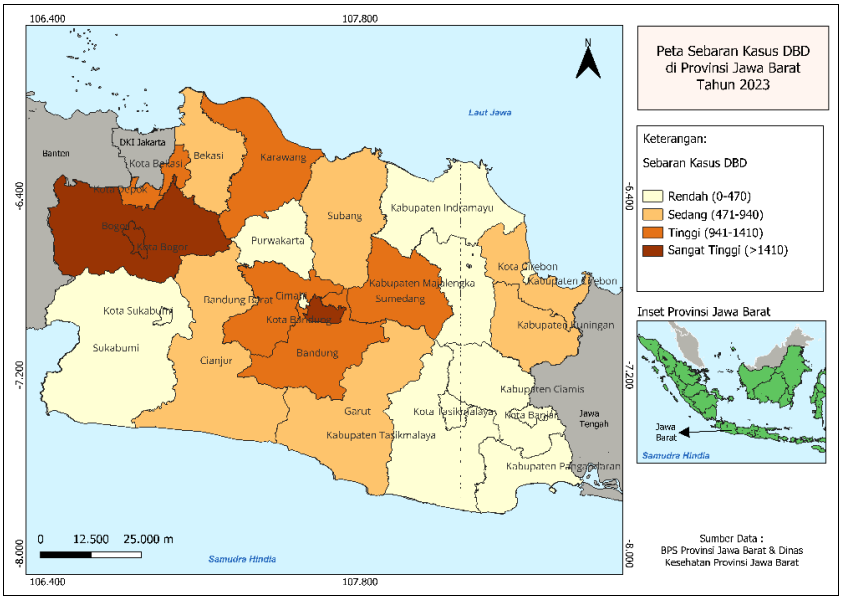

Figure 1. Distribution Map of Dengue Cases in West Java Province in 202

There are 19,328 dengue cases from 27 districts and cities in West Java Province in 2023. Dengue cases are widely spread in the West Java region and can be grouped into four classifications, low, medium, high, and very high. Based on the map in figure 1, it is known that the most dengue cases in West Java Province in 2023 were in Bogor Regency with 1881 cases, Bandung City with 1856 cases, and Bogor City with 1474 cases. Meanwhile, the area with the lowest dengue cases is in Banjar City with 53 cases.

Distribution of Population Density in West Java Province in 2023

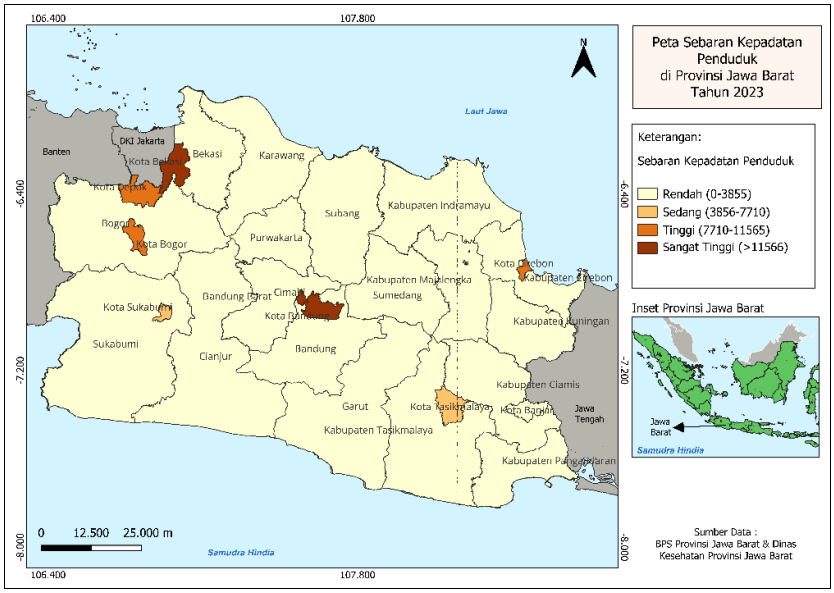

Figure 2. Population Density Distribution Map in West Java Province in 2023

Based on the map in figure 2, it is known that the population density in West Java Province is dominated by areas with low population density. However, there are also several areas with very high population density in the city of Bandung, Bekasi City and Cimahi City.

Distribution of Regional Altitude in West Java Province in 2023

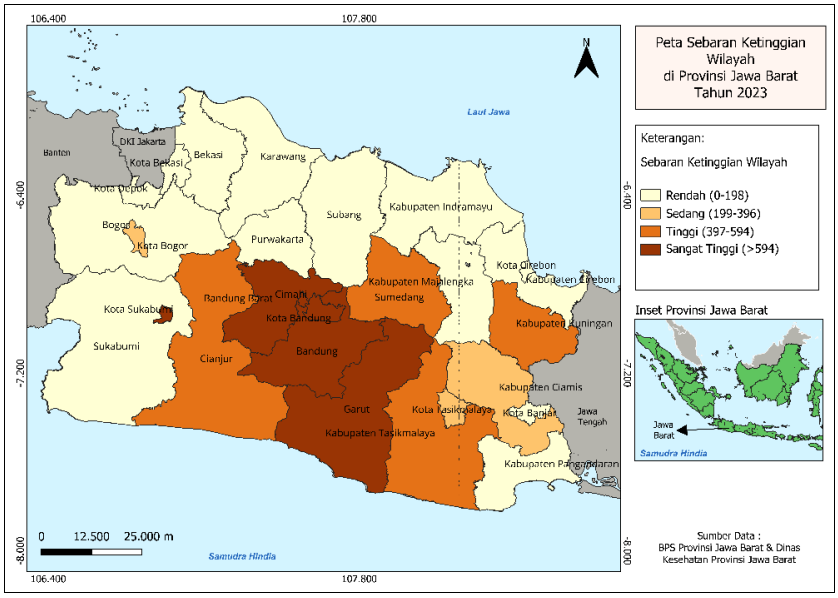

Figure 3. Map of Regional Elevation Distribution in West Java Province in 2023

Based on the map in figure 3, it is known that West Java Province is dominated by areas with low altitudes, such as Cirebon City, Banjar City, Depok City, Bekasi City, Bekasi Regency, Pangandaran Regency, Majalengka Regency, Sukabumi, Karawang Regency, Indramayu Regency, Cirebon Regency, Purwakarta Regency, Subang Regency, and Bogor Regency. However, there are also areas with very high altitudes, in Cimahi, West Bandung Regency, Garut Regency, Bandung Regency, Bandung City, and Sukabumi City.

Distribution of the Percentage of Households with Proper Sanitation in West Java Province in 2023

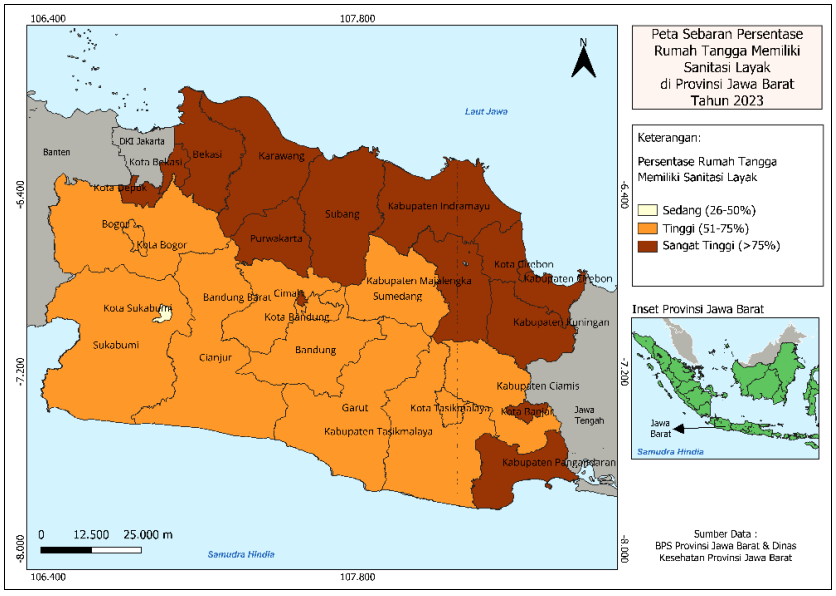

Figure 4. Distribution Map of the Percentage of Households with Decent Sanitation in West Java Province in 2023

Based on map in figure 4, there is no area with a low percentage of households with decent sanitation, but there's one area with a percentage of households with decent sanitation for the

medium category is in Sukabumi City and other areas filled with high and very high percentage of households with decent sanitation.

Distribution of the Percentage of Poor Population in West Java Province in 2023

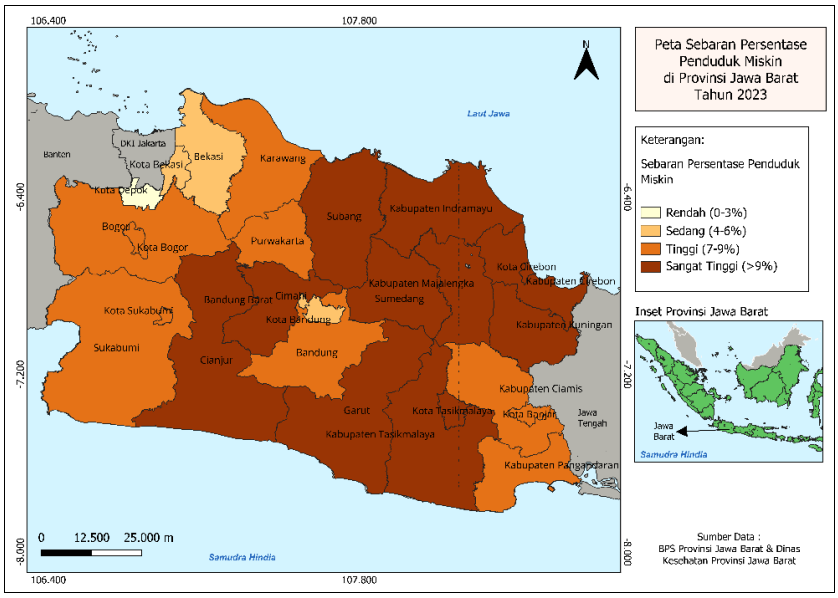

Figure 5. Map of the Distribution of the Percentage of Poor Population in the Province West Java in 2023

Based on the map in figure 5, it is known that West Java is dominated by the poor, with the highest percentage of poor people in Cirebon City, Tasikmalaya City, Tasikmalaya Regency, Majalengka Regency, Indramayu Regency, Kuningan Regency, Cirebon Regency, Cianjur Regency, West Bandung Regency, Sumedang Regency, Garut Regency, and Subang Regency. Meanwhile, the area with the lowest percentage of poor people is in Depok City.

Vulnerability Level of Dengue Cases in West Java Province in 2023

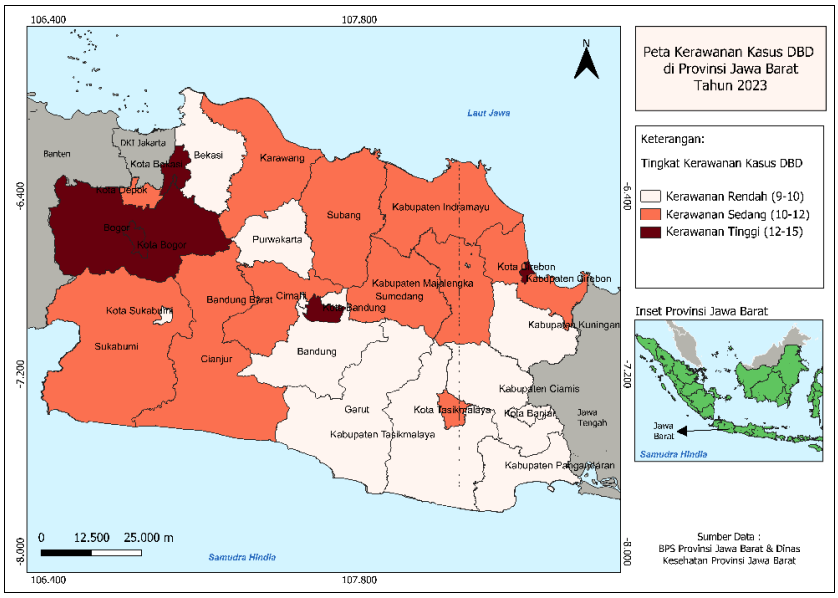

Figure 6. Map of the Vulnerability Level of Dengue Cases in West Java Province in 2023

The determination of the vulnerability area of dengue cases was obtained from the results of the sum of variable scoring, then three categories of vulnerability levels are produced, low

vulnerability, medium vulnerability, and high vulnerability. Based on the map in figure 6, it is known that the areas with the highest level of dengue vulnerability are in Bogor City, Bekasi City, Bandung City, Bogor Regency, and Cirebon City. As for the lowest dengue vulnerability is in Cimahi, Sukabumi City, Purwakarta Regency, Garut Regency, Kuningan Regency, Ciamis Regency, Banjar City, Tasikmalaya Regency, Bandung Regency, Pangandaran Regency, and Bekasi Regency.

Table 3.
Total Score and Vulnerability Level of Dengue in West Java Province in 2023

Regency/City	Score					Total	Ket
	Dengue Cases	Population Density	Altitude of the Region	Sanitation is Feasible	Poor Population		
Bogor City	4	3	3	2	3	15	High
Bekasi City	3	4	4	1	2	14	High
Bogor Regency	4	1	4	2	3	14	High
Cirebon City	1	3	4	1	4	13	High
Bandung	4	4	1	2	2	13	High
Karawang Regency	3	1	4	1	3	12	Medium
Sumedang District	3	1	2	2	4	12	Medium
Cirebon Regency	2	1	4	1	4	12	Medium
Depok City	3	3	4	1	1	12	Medium
Subang Regency	2	1	4	1	4	12	Medium
Tasikmalaya City	1	2	3	2	4	12	Medium
Cianjur Regency	2	1	2	2	4	11	Medium
Majalengka Regency	1	1	4	1	4	11	Medium
Sukabumi Regency	1	1	4	2	3	11	Medium
West Bandung Regency	3	1	1	2	4	11	Medium
Indramayu Regency	1	1	4	1	4	11	Medium
Bekasi Regency	2	1	4	1	2	10	Low
Pangandaran Regency	1	1	4	1	3	10	Low
Bandung Regency	3	1	1	2	3	10	Low
Tasikmalaya Regency	1	1	2	2	4	10	Low
Banjar City	1	1	4	1	3	10	Low
Ciamis Regency	1	1	3	2	3	10	Low
Kuningan Regency	2	1	2	1	4	10	Low
Garut Regency	2	1	1	2	4	10	Low
Purwakarta Regency	1	1	4	1	3	10	Low
Sukabumi City	1	2	1	3	3	10	Low
São Paulo	1	4	1	1	2	9	Low

Based on the total scoring of dengue vulnerability levels in West Java Province, the area with the highest level of vulnerability is Bogor City, then there are 16 districts/cities with moderate levels of vulnerability. If sorted based on five priority areas for handling dengue cases, namely Bogor City, Bekasi City, Bogor Regency, Cirebon City, and Bandung City.

DISCUSSION

West Java Province is geographically located between 5°50′ – 7°50' South Latitude and 104°48' – 108°48′ East Longitude, located in the western part of Java Island with an area of 37,851.11 (West Java Profile). The North Coast area (Pantura) is a lowland. West Java Province is one of the provinces that has a large population and a large area. This is supported by data that states that West Java is the province with the largest population in Indonesia, which is 49,900 people in 2023 (Indonesian Health Profile, 2023). km^2 West Java Province has a diverse topography, consisting of lowlands in the north (Pantura), hills in the middle, and mountains in the south and east. The altitude of the area ranges to more than 2,500 meters

above sea level, with the highest point being on Mount Ciremai at about 3,078 meters. Thus, this topography affects the local climate, air temperature, and humidity which can directly impact the spread of Aedes Aegypti mosquitoes and other factors related to dengue.
The vulnerability of dengue cases can be interpreted as the level of risk of a region against the spread of dengue disease based on environmental, social, and biological factors. Areas with high levels of vulnerability have conditions that support the growth and spread of Aedes mosquitoes. This vulnerability is also supported by factors of high population density, poor sanitation, and climatic factors that favor vector development. From the results of the analysis, Bogor City, Bekasi City, Bandung City, Bogor Regency, and Cirebon City are the areas with the highest level of vulnerability. This shows that these areas have a combination factor that support the increase of dengue cases, so more attention is needed in disease control and prevention efforts. One of the factors that is suspected to be the cause of the rapid increase in dengue cases is population density. Population density can be interpreted as the number of people living in an area, causing high population mobility in the region (Qamila & Krama., 2018). The topography of West Java affects the distribution of population density, where low-lying areas such as Bekasi, Bandung, and Bogor tend to have high population density. This density can increase the risk of spreading dengue virus, because the proximity of the house makes it easier for mosquitoes to move from one individu to another.

In this study, areas with high population density have a high level of vulnerability also in increasing the risk of dengue incidence, such as the cities of Bandung, Bekasi and Cimahi which have a high population. These results are supported by research conducted by Hidayati et al. (2023) which showed the results of a positive correlation analysis between population density factors and dengue incidence in Bantul Regency in 2022. Population density easily transmits the dengue virus, because population density correlates with mosquito flight distance and dengue transmission. This shows that the higher the population density, the easier it will be for dengue transmission to occur. Research conducted by Kusaira & Yulia (2020), shows that the highest cases of dengue occur in areas with high population density. This result is strengthened by Marlena's research, which states that population density and proximity to nearby houses make the spread of the dengue virus more easily (Kusumawati N, Sukendra D., 2020). Population density is the main factor in the spread of dengue, because the virus can be transmitted quickly to other people (Dewi A & Sukendra D., 2018). The result of the study was different from Rafdi's research (2019) which found that population density had no effect on the incidence of dengue.

The altitude of the region in West Java varies greatly, higher area generally has lower temperatures, so it can inhibit mosquito breeding. However, low-lying areas such as Cirebon, Bekasi, and Karawang, have warmer temperatures and higher humidity levels, thus supporting the growth of Ae Aegypti mosquitoes. The altitude of an area correlates with temperature and humidity, which are important factors that affect the breeding of Aedes mosquitoes. The lower the location of an area, the higher the temperature and humidity, but this is not absolute, because temperature and humidity are also influenced by other factors such as rainfall. The environmental risk factor of Ae aegypti mosquitoes is that these mosquitoes thrive at an altitude of 0-500 meters above sea level and are not suitable for survival at altitudes above 1000 meters, so the risk of dengue transmission in higher areas is relatively low. This condition is influenced by the impact of altitude on climate factors (Wulandari R., 2023). Based on the results of this study, it was found that areas with lower levels of vulnerability to dengue fever, such as in Cirebon City, Banjar City, Depok City, Bekasi City, Bekasi Regency, Pangandaran Regency, Majalengka Regency, Sukabumi, Karawang, Indramayu Regency, Cirebon Regency, Purwakarta, Subang, and Bogor Regency. This is evidenced by research conducted by Istiqamah et al (2020), which stated that there is a relationship between the

altitude of the area and dengue cases in Kediri City in 2014-2018. Lower regions have a higher risk level in the spread of dengue cases.

Environmental factors that affect the increase in dengue cases are due to poor sanitation factors, the presence of larvae in water reservoirs (TPA), the presence of artificial or natural containers in landfills. People's habits that do not care about environmental cleanliness can also increase the risk of dengue fever. Another bad habit can occur when people find it difficult to get clean water, so they store water in a water tub which, if not cleaned frequently, can become a potential breeding ground for Ae Aegypti mosquitoes. Nationally, the percentage of households that have access to proper sanitation is 82.36%. In 2023, the highest percentage of households with access to proper sanitation will be in the provinces of DI Yogyakarta (96.42%), Bali (95.70%), and South Sulawesi (93.69%). Meanwhile, the provinces with the lowest percentage are in Papua Province (43%), West Sumatra (70.97%), and West Java (74.88%). Good sanitation is an important element to support human health (Indonesian Statistics, 2024).

Sanitation, according to WHO, refers to the provision of facilities and infrastructure for the disposal of human waste, such as urine and feces. The term sanitation refers to hygienic conditions obtained through waste and liquid waste management efforts. Poor sanitation conditions will have a negative impact on environmental quality, pollution of drinking water sources, and the emergence of various diseases. According to Statistics Indonesia, the definition of households that have access to proper sanitation is sanitation facilities that meet health requirements, including toilets using goose necks, fecal disposal sites that use septic tanks, and these sanitation facilities are used by their own households, together with certain other households, or in communal toilets (Indonesian Health Profile, 2023). Poor environmental sanitation is more common in low-lying and densely populated urban areas, such as Bekasi and Bogor. However, based on the mapping results, it is known that there are no areas with a low percentage of households with decent sanitation, but there are areas with a percentage of households with moderate sanitation in Sukabumi City. This shows that people in West Java already have good behavior in maintaining household sanitation.

Research by Bulu, et al. (2022) found that there was a meaningful relationship between dengue and environmental factors in the house of water and waste storage, waste management, and the presence of larvae. Furthermore, the results of Mahardika's (2021) research show that health behavioural factors are significantly related to the incidence of dengue, including water reservoirs, water reservoir covers, draining water reservoirs, and burying used goods. Research according to Fullerton, et al. (2014) states that sanitation facilities and proper access to drinking water have an influence in reducing susceptibility to diseases caused by the dengue virus, this is because the population becomes less sensitive to the presence of Ae Aegypti mosquitoes and the ability of the community to handle the disease better.

According to the Central Statistics Agency (BPS), the concept of poverty is defined as the economic inability to meet basic needs such as food and not only in terms of spending. The population is categorized as poor if it has an average per capita expenditure per month below the poverty line. Indonesia is one of the countries that measures poverty data using the level of per capita expenditure with the concept of ability to meet basic needs. The poverty factor is one of the factors in the spread of the dengue virus, because poor people have limited access to health services, living conditions that do not meet health standards, and lack of education about the prevention of infectious diseases in the community. So that areas with a high percentage of poor people will be easier to spread the dengue virus.

The results of the mapping based on the percentage of the poor population are found to be the highest percentage of poor people in Cirebon City, Tasikmalaya City, Tasikmalaya Regency, Majalengka Regency, Indramayu Regency, Kuningan Regency, Cirebon Regency, Cianjur, West Bandung, Sumedang, Garut, and Subang. According to research by Wowor (2017), in addition to natural environmental factors, factors such as population density that is not balanced with decent settlements and poverty factors are supporting factors in the spread of dengue. However, different results were obtained from research by Valgunadi & Chairani (2023), which stated that the poverty factor did not have much effect on dengue cases. Prevention and control of dengue cases need to be carried out by involving various sectors, one of which is health facilities which are the first forum for dengue fever sufferers. Preventive behaviour is one of the main activities to break the mosquito chain. Prevention activities can start from oneself by increasing immunity, as well as environment-based prevention in the form of mosquito nets eradication due to mobilization (Ministry of Health of the Republic of Indonesia, 2019). Research by Sinaga et al (2019) states that there is a meaningful relationship between PSN behaviour and dengue incidence.

CONCLUSION

Dengue cases in West Java Province are most common in Bogor Regency, Bandung City, and Bogor City. From the scoring results, the vulnerability of dengue cases was categorized into three categories, namely low, medium, and high. The areas that are priorities in handling dengue cases are Bogor City, Bekasi City, Bandung City, Bogor Regency, and Cirebon City which are the areas with the highest level of vulnerability. By knowing the distribution of dengue vulnerability levels in West Java Province in 2023, it is hoped that it can make it easier to prevent and handle dengue cases. Various efforts can be made to break the chain of dengue disease transmission, namely by improving environmental sanitation, immediate treatment for sufferers, and increasing public understanding of dengue

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