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Association of Rainfall Intensity with Case and Prevalence Patterns of Dengue Hemorrhagic Fever (DHF)

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Kata Kunci

Curah Hujan;
Prevalensi;
Demam Berdarah Dengue;
Jawa Barat
Indonesia

Abstrak

Salah satu penyakit menular yang memiliki angka morbiditas dan mortalitas tinggi adalah penyakit Demam Berdarah Dengue (DBD) yang ditularkan melalui gigitan nyamuk *Aedes aegypti* dan *Aedes albopictus*. Di Provinsi Jawa Barat kasus DBD berfluktuasi. Sehingga perlu dilakukan analisis dan peninjauan pengaruh cuaca dengan kasus DBD di Provinsi Jawa Barat dengan pola dan prevalensi kasus DBD di seluruh kota dan kabupaten di Provinsi Jawa Barat. Jenis penelitian ini merupakan penelitian deskriptif kuantitatif dengan melakukan observasi yang bersifat eksploratif dang menghasilkan sesuatu yang bersifat umum dengan pendekatan *Geographic System Information.* Lokasi penelitian ini di seluruh 27 kabupaten dan kota di Provinsi Jawa Barat. Data kasus DBD di Provinsi Jawa Barat diakses dari Dinas Kesehatan Provinsi Jawa Barat pada platform Open Data Jabar (https://opendata.jabarprov.go.id/). Kemudian data penduduk Provinsi Jawa Barat dapat diakses pada Badan Pusat Statistik Provinsi Jawa Barat pada platform https://jabar.bps.go.id/. Analisis data penelitian ini untuk insiden dihitung dengan cara jumlah kasus dibagi jumlah penduduk lalu dikalikan seratus ribu, sedangkan prevalensi dapat dihitung dengan cara jumlah kasus dibagi jumlah penduduk lalu dikalikan seribu, dan pemetaan menggunakan QGIS 3.16. Dari tahun 2014 – 2020, kasus tertinggi pada Kota Bandung dan Prevalensi tertinggi pada Kota Sukabumi. terdapat hubungan curah hujan dengan kasus DBD di Provinsi Jawa Barat Tahun 2014 - 2020 dengan kekuatan korelasi yang sedang dimana curah hujan memberikan peran terhadap timbulnya kasus DBD tetapi tidak bersifat mutlak karena masih dapat dipengaruhi oleh faktor lainnya.

Keywords

Rainfall Intensity;
Prevalence;
Dengue Hemoragic Fever;
West Java Indonesia

Abstract

One of the infectious diseases that have high morbidity and mortality rates is Dengue Hemorrhagic Fever (DHF) which is transmitted through the bite of Aedes aegypti and Aedes albopictus mosquitoes. In West Java Province, dengue cases fluctuated. So it is necessary to analyze and review the influence of weather on dengue cases in West Java Province with the pattern and prevalence of dengue cases in all cities and districts in West Java Province. This type of research is quantitative descriptive research by making exploratory observations and producing something general with a Geographic Information System approach. The location of this research is in all 27 districts and cities in West Java Province. Data on dengue cases in West Java Province is accessed from the West Java Provincial Health Office on the West Java Open Data platform (https://opendata.jabarprov.go.id/). Then the population data of West Java Province can be accessed at the Central Statistics Agency of West Java Province on the https://jabar.bps.go.id/ platform. Analysis of this research data for incidence is calculated by dividing the number of cases divided by the population and then multiplying by one hundred thousand, while the prevalence can be calculated by dividing the number of cases divided by the population and then multiplying by a thousand, and mapping using QGIS 3.16. From 2014 – 2020, the highest cases were in the city of Bandung and the highest prevalence was in the city of Sukabumi. there is a relationship between rainfall and DHF cases in West Java Province in 2014 - 2020 with a moderate correlation strength where rainfall plays a role in the incidence of DHF cases but is not absolute because it can still be influenced by other factors.

Introduction

One of the infectious diseases that have a high morbidity and mortality rate is Dengue Hemorrhagic Fever (DHF). Dengue hemorrhagic fever (DHF) is a disease that is commonly found in most tropical and subtropical regions, especially Southeast Asia, Central America, America and the Caribbean (1). The number of DHF cases has never decreased in some tropical and subtropical areas and even tends to increase (2) and causes many deaths in children (3). 90% of them attack children under 15 years old (3). In Indonesia, every year there are always outbreaks (Extraordinary Events) in several provinces, the largest occurred in 1998 and 2004 with 79,480 sufferers with more than 800 deaths (4).

DHF is caused by the dengue virus which is transmitted through the bites of the Aedes aegypti and Aedes albopictus mosquitoes (5). These two types of mosquitoes are found in almost all corners of Indonesia, except in places with an altitude of more than 1000 meters above sea level (6). All regions in Indonesia are at risk of contracting dengue hemorrhagic fever, because both the virus that causes it and the mosquitoes that transmit it are widespread in residential areas and public places throughout Indonesia, except for places above 100 meters above sea level (7). Almost every year the high DHF cases occur in several areas during the rainy season. This disease is still a public health problem and is endemic in some districts/cities in Indonesia (8).

According to Indonesia Health Profile 2021, the incidence rate of dengue hemorrhagic fever in Indonesia from 2012-2021 per 100,000, in general, has increased. In 2018, the incidence rate of Dengue Hemorrhagic Fever was 24.8 then in 2019, it increased to 51.5. This is different when in 2021 which decreased to 27 (9). However, the case fatality rate significantly increased from 0.69% in 2020 to 0.96% in 2021.

The highest dengue haemorrhagic fever cases in Java Island, Indonesia were in West Java Province. The incidence rate/IR was 47.8 per 100,000 population. The highest cases occurred in the 3rd month of 2004 (395 cases), but in the following month decreased to 12 cases. In early January 2005, there was an increase in cases until 2011 (10). The city of Sukabumi was ranked first in the province of West Java for dengue cases from 2010 to 2013 and was followed by the cities of Bandung and Cimahi (West Java Provincial Health Office 2015). Patients with DHF in Sukabumi City from 2011 to 2014 are still high, although there has been a decrease in cases in 2011 there were 531 cases (IR = 149.12), but in 2012 there was an increase, recorded DHF patients as many as 922 cases (IR = 252.88), 597 cases (IR = 174.52) in 2013, and about 801 cases (IR = 254.28) in 2014 (11). Thus, West Java Province is an area where several districts/cities have become endemic areas for dengue virus infection, in 2020 all districts/cities in West Java had declared extraordinary events in their area. The average rainfall intensity in 2020 in West Java was 59.8 mm (12).

The distribution of dengue cases is strongly influenced by environmental factors. Physical environmental factors that affect vector life are rainfall, temperature, evaporation, and container water content, such as organic matter, microbial communities, and aquatic insects in the container (13). Abiotic factors such as rainfall, temperature, and evaporation can affect the failure of mosquito eggs, larvae, and pupae to become imago. Climate change causes changes in rainfall, temperature, humidity, and air direction so it affects land and ocean ecosystems and affects health (14). Rainfall has a direct influence on the existence of Aedes aegypti breeding sites. The population of Aedes aegypti depends on the place of breeding for mosquitoes. Rainfall (mm) is the height of rainwater that falls on a flat place with the assumption that it does not evaporate, does not seep and does not flow. Heavy rainfall that lasts for a long time can cause flooding so that it can eliminate the breeding ground for Aedes mosquitoes which usually live in clean water. As a result, the number of breeding mosquitoes will decrease. However, if the rainfall is small and for a long time, it will add to the breeding places for mosquitoes and increase the mosquito population.

Based on the above background, it is necessary to analyze and review the influence of weather on dengue cases in West Java Province with the dengue hemorrhagic fever cases pattern and prevalence rate in all cities and districts in West Java Province.

Methods

This type of research is spatial analysis research that does not make comparisons or links between variables and hypotheses. This is exploratory observation research and produces something general with a Geographic Information System approach. The location of this research is in all 27 districts and cities in West Java Province. The object of this research is all people who have been registered in all health services (including hospitals, Puskesmas poskesdes, and so on) as cases of dengue hemorrhagic fever (DHF) from 2014-2020. DHF case data in West Java Province is accessed from the West Java Provincial Health Office on the West Java Open Data platform (https://opendata.jabarprov.go.id/). The coordinates of the research object are obtained from the digitization process using GPS. Descriptive and prevalence analyzes were conducted to determine the distribution and prevalence of cases of dengue hemorrhagic fever (DHF) in West Java Province from 2014-2020. Then the population data of West Java

Province can be accessed at the Central Statistics Agency of West Java Province on the https://jabar.bps.go.id/ platform. This study does not use validity and reliability tests because it uses secondary data. Analysis of this research data for incidence is calculated by dividing the number of cases divided by the population and then multiplying by one hundred thousand, while the prevalence can be calculated by dividing the number of cases divided by the population and then multiplied by one thousand, and mapping using QGIS 3.16.

Results

A pattern of DHF Cases in West Java Province 2014-2020

The incidence of Dengue Hemorrhagic Fever (DHF) is evenly found throughout West Java Province which covers 27 districts/cities. Overall, the total number of dengue cases reported in West Java Province during 2014-2020 was 146,644 cases. Figure 1 shows that the city/regency with the highest number of DHF cases in 7 years is occupied by the City of Bandung. Starting in 2014 there were 3,132 cases, in 2015 there were 3,640 cases, in 2016 there were 3,881 cases, in 2017 there were 1,786 cases, in 2018 there were 2,826 cases, and in 2019-2020 the number of cases remained the same at 4,424 cases. Next, followed by Bandung Regency and Bekasi City which have high cases under Bandung City.

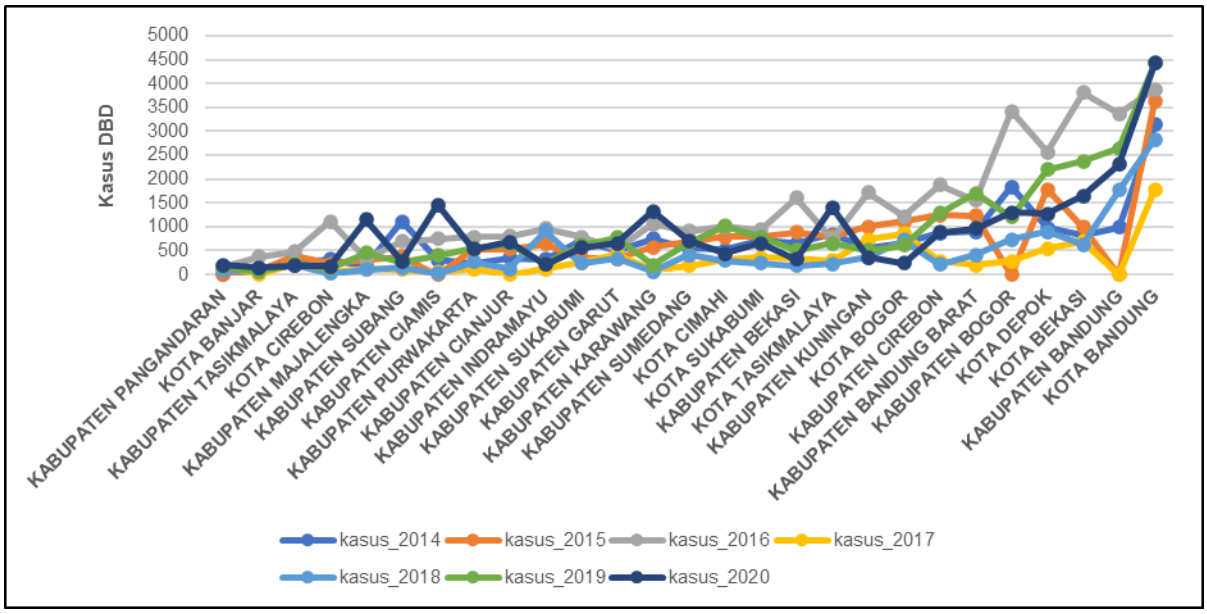

Figure 1. A pattern of DHF Cases in West Java Province from 2014 until 2020

Figure 1 shows the trend of dengue cases in West Java Province in the period 2014-2020 experienced high fluctuations, with a drastic decrease in cases only in 2017. The district/city with the lowest number of cases in the last 7 years was occupied by Pangandaran Regency. In 2014 there were 13 cases, in 2015 there were 16 cases, in 2016 there were 143 cases, in 2017 there were 175 cases, in 2018 there were 75 cases, in 2019 there were 158 cases and in 2020 there were 196 cases.

West Java Province DHF Prevalence Pattern in 2014-2020

Prevalence is the proportion of people with a disease in a population at a point in time or period. The prevalence of dengue cases in West Java Province can be seen in Figure 2 above, which covers 27 regions in West Java Province. Of the 27 regions in West Java province, the highest prevalence of dengue cases was occupied by the city of Sukabumi with details of prevalence in 2014 as many as 223.81, in 2015 as many as 249.28, in 2016 as many as 293.37, in 2017 as many as 108.71, in 2018. as many as 72.94, in 2019 as many as 239.14, and in 2020 as many as 196.86. The higher the population, the higher the prevalence. How to calculate the prevalence of each region can use the formula:

$$\text{Prevalence} = \frac{\text{Total Cases}}{\text{Total population}} \times 100{,}000$$

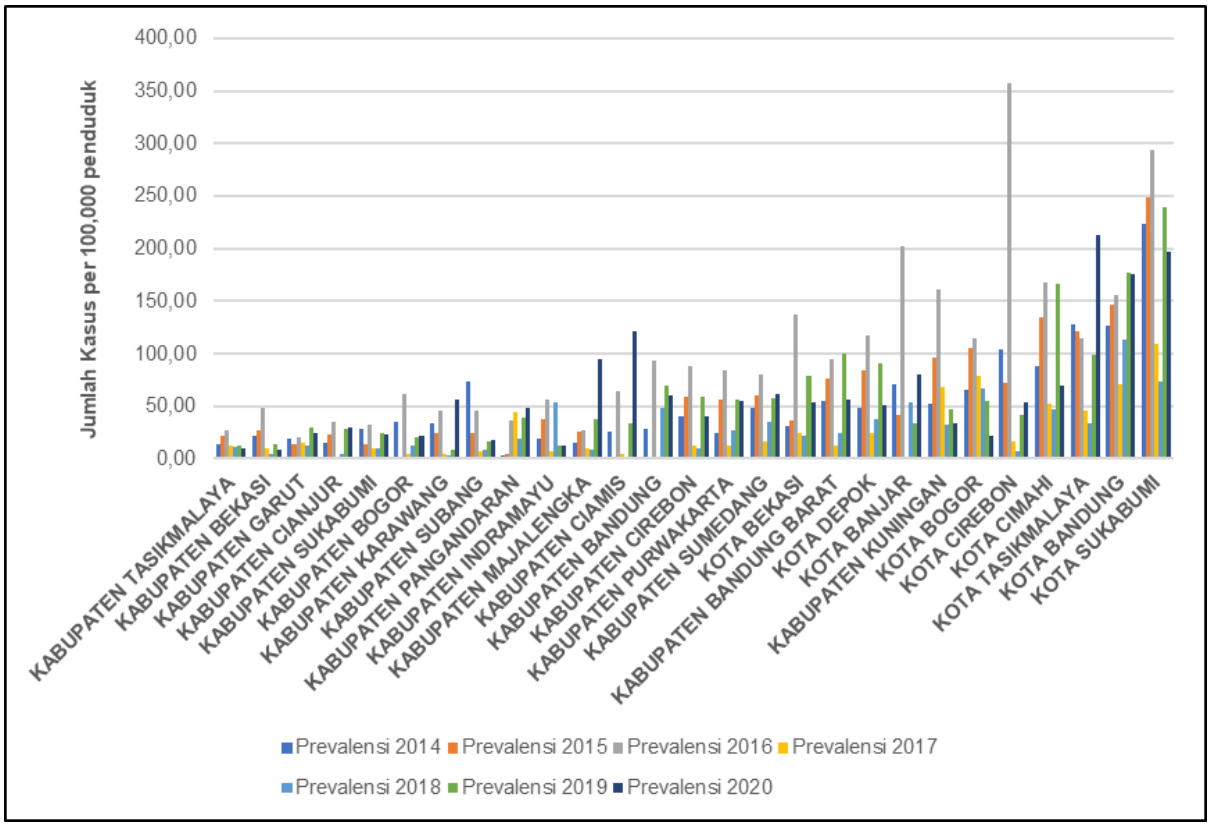

Figure 2. DHF Cases Prevalence Pattern in West Java Province from 2014 until 2020

In addition to the prevalence pattern depicted by a bar graph (bar plot) in Figure 2, Figure 3 shows a spatial map of the prevalence pattern of DHF cases in West Java Province from 2014-2020. Spatial analysis was conducted to observe the pattern of distribution of cases based on the geographic area from year to year.

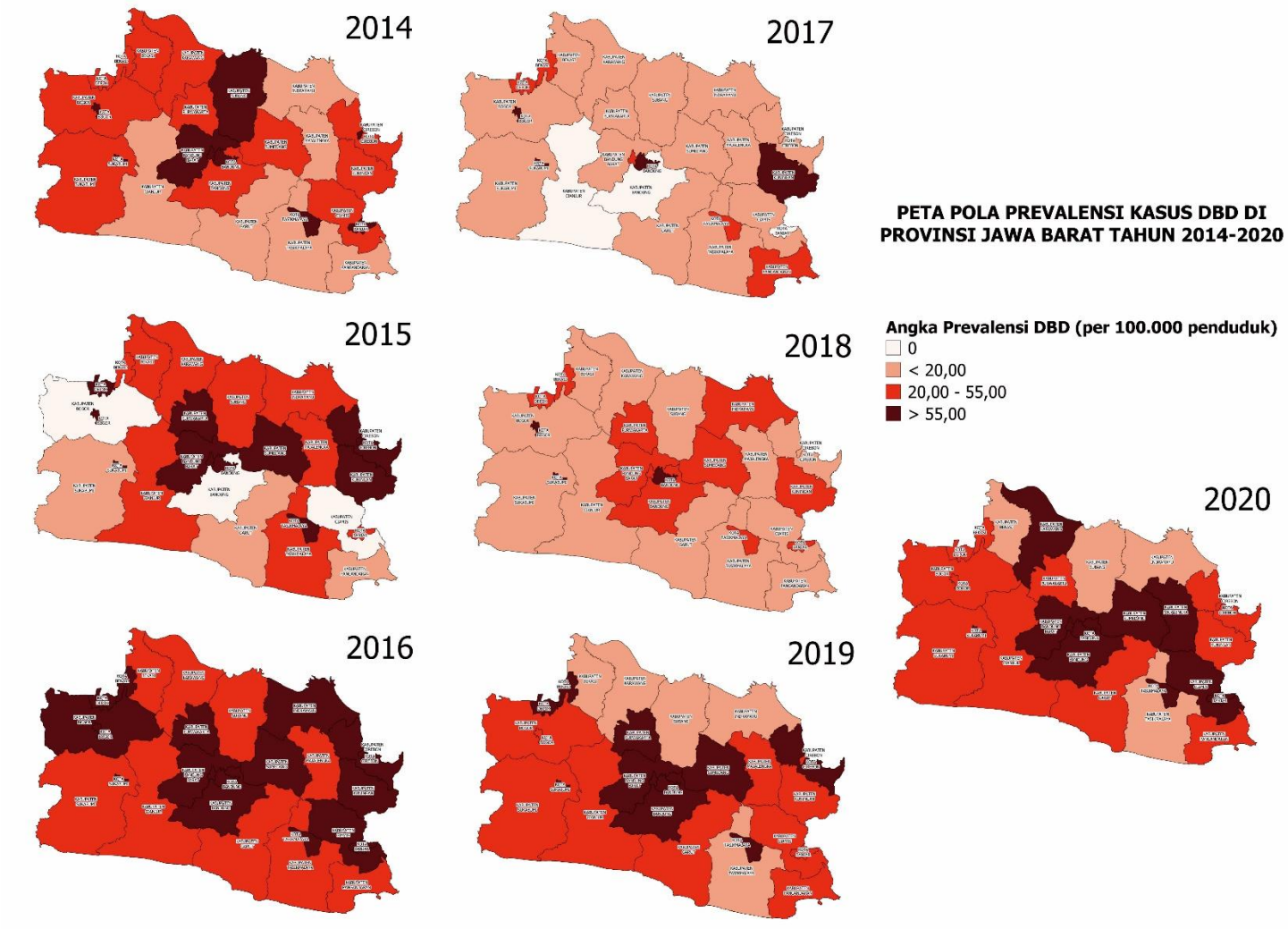

Figure 3. Spatial Analysis of the Prevalence Pattern of DHF Cases in West Java Province 2014-2020

Figure 3 shows that in 2016 and 2020 dengue cases were dominant in several cities and regencies in West Java Province which were located in close geographical locations. In 2016 and 2020, the highest average prevalence of cases was in the following cities: Bekasi, Depok, Bogor, Bandung Banjar, Cirebon, and several districts including Bogor, Purwakarta, West Bandung, Bandung, Sumedang, Indramayu, Cirebon, Kuningan , and Ciamis. 2017 was the year with the lowest prevalence of cases, Bandung Regency, Cianjur Regency and Banjar City found no cases, while the majority of other areas had a low prevalence of DHF (<20.00). 2016 was the year with the worst prevalence of DHF cases, there was only moderate (20.00-55.00) and high (>55,00) prevalence in the central, eastern and western parts of the province. Overall, during 2014-2020, Sukabumi City and Bandung City always had a high prevalence of dengue cases. Each year the high prevalence is concentrated in the central region of the province, while the low prevalence is concentrated in the northern region of the province.

Cumulative Rainfall Intensity of West Java Province in 2014-2020

To further analyze the relationship between DHF cases and rainfall factors, the following is an image of the cumulative rainfall mapping in West Java Province from 2014 – 2020.

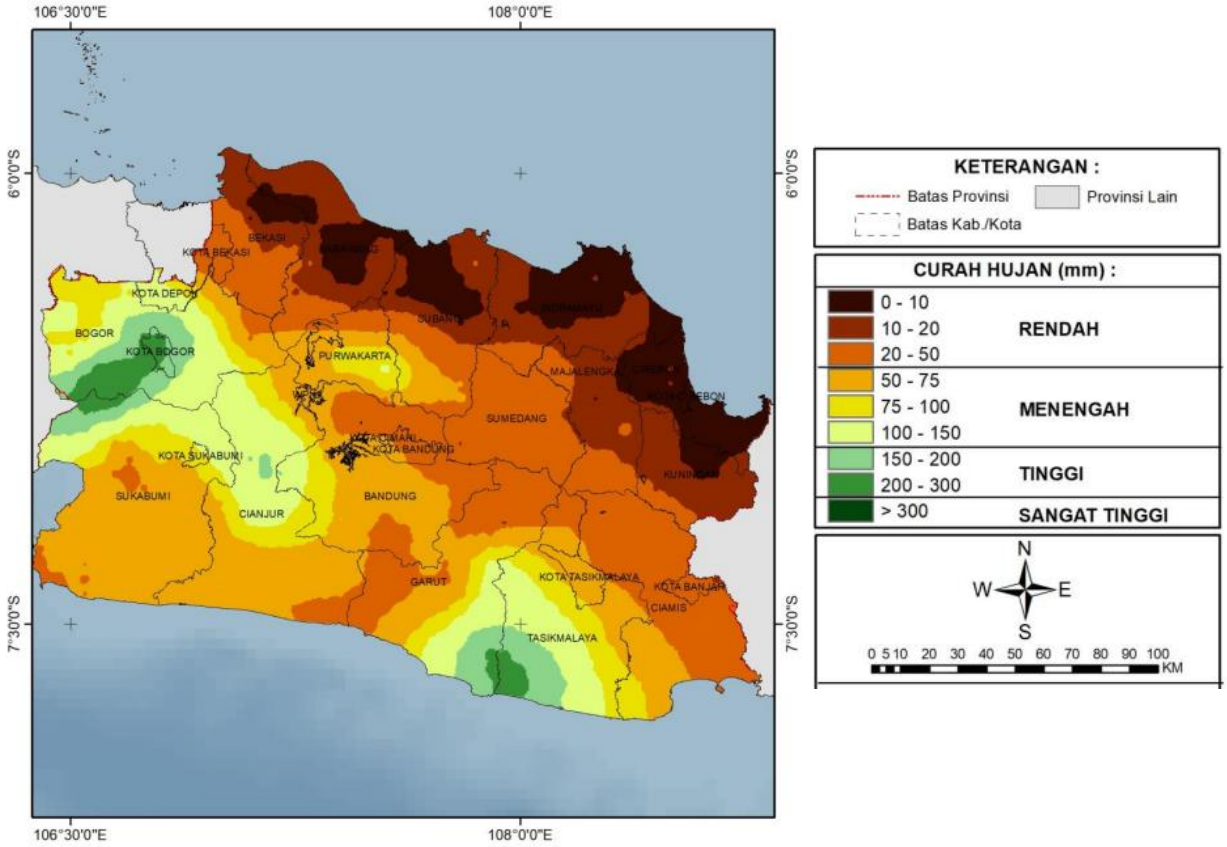

Figure 4. Map of Cumulative Rainfall in West Java Province 2014-2020

Based on Figure 4 above, shows that in 2014-2020 the majority of districts and cities in West Java Province had medium rainfall ranging from 50-150 mm in the areas of Depok City, Purwakarta, Sumedang, Bandung City, Bandung Regency, Tasikmalaya City, Ciamis, Garur Cianjur, Sukabumi Regency, Sukabumi City. Regencies and cities with low rainfall are located in the north of West Java Province, including Bekasi, Karawang, Subang, Cirebon, and Majalengka. Meanwhile, areas with high rainfall include Bogor City, Bogor Regency and Tasikmalaya Regency.

Discussion

The incidence of dengue cases in the city of Bandung fluctuated for 7 years from 2014 to 2020. The highest cases occurred in 2019 and 2020 (4,424 cases) and the lowest cases occurred in 2017 (1,786 cases). Likewise, Pangandaran district fluctuated for 7 years from 2014 to 2020. The highest cases occurred in 2020 (196 cases) and the lowest cases in 2014 (13 cases). DHF cases in West Java province fluctuated due to various factors including climate change in terms of rainfall (dominant factor), knowledge and behaviour of the population, population density to the high incidence of flooding in each region. This is following Henrik L. Blum's theory which states that health is closely related to

environmental factors, behaviour, and health services. What is stated is that the environment in this case changes in temperature, rainfall, and air humidity.

The pattern of dengue cases in West Java, especially Bandung City, has tended to increase in the last 7 years, with the most cases reaching 4,424 cases in 2019 and 2020. During the last 50 years from 1968 to 2017, the incidence rate of DHF in Indonesia has continued to increase with a pattern of cycle peaks every 6-8 years, while the number of deaths has decreased since 1980 (15). An estimated 1.4 billion increase in the population at risk of dengue fever in urban areas of Africa and Southeast Asia. This epidemic belt will expand globally to 4.7 billion people by 2070, mainly in low-lying and urban areas (16).

The city of Bandung as the provincial capital has many cultural heritages of historic old buildings which are tourist sites. Visiting the old building in the rainy season which is high in dengue transmission contributes to the high number of cases. Old buildings allow many sources of mosquito breeding, outdated construction, lack of piped water, inadequate sewage disposal facilities and dark and damp conditions (17). The large number of co-infected cases reported in Nigeria and India can be fatal if not diagnosed and reported, whereas malaria-dengue is the most common co-infection case globally. Virus serotype DEN-4 is the most common serotype found in cases of dengue coinfection (18).

Judging from the meteorological conditions, areas with medium to high rainfall in West Java Province almost always appear in DHF cases every year. This is influenced by the monsoon cycle in tropical countries such as Indonesia and the Philippines, where meteorological conditions of maximum rainfall, relative humidity and temperature are always followed by dengue epidemics (19). The value of weekly rainfall at lag 3 and 4 weeks in the city of Bandung is the best predictor of dengue fever case indicators Ovitrap Index (OI) and Ovitrap Density Index (ODI) in people's homes and public places. Overlap is an effective tool for monitoring the population dynamics of Aedes sp mosquitoes as early detection of dengue cases in the environment (20).

However, the sensitivity and adaptive capacity of the West Java Provincial Government to climate change have a positive impact on the incidence of DHF in the future, because the risk analysis tends to be low in 2010, 2015 and 2016 when El Nino and La Nina extreme climates occur. This effort is evidenced by the adequate number of puskesmas and hospitals per city or district (21). Furthermore, the launch of a meteorology-based DHF early warning system (temperature and rainfall) is the best solution at this time. Other indicators, namely entomology, epidemiology, population and socio-economics, can be used as support. So it is necessary to improve the timeliness, quality and transparency of data to develop a more effective system (22).

In addition to weather factors from cumulative rainfall, the top 5 cities/districts with the highest number of dengue cases are also influenced by population density factors in urban areas, altitude, and insect resistance to chemical insecticides. Urbanization is a driving factor for dengue fever due to the high interaction between mosquito breeding sites and dense population, as well as population mobility in the provision of goods and services (16). Bekasi City, Depok City, and Bogor Regency which are located at an altitude below 500 m have a high risk of dengue outbreaks, while areas at an altitude between 500-1500 m are at moderate risk (23). In Indonesia, it was found that 84% of districts were resistant to malathion 0.8%, 49% districts were resistant to temephos larvicide 0.02%, 98% districts were resistant to cypermethrin 0.05%, 40% districts were resistant to alpha-cypermethrin 0.025% and 65 % of districts resistant to deltamethrin 0.025% (24).

Other efforts to prevent and control dengue cases can be done by vaccinating children with dengue (aged 5–14 years, biocontrol of dengue virus through Wolbachia pipientis bacteria present in the body of the Aedes aegypti mosquito, as well as the use of vegetable insecticides such as bay, leaves in an electric liquid vaporizer). 25–27. Natural insecticides are easily degraded and relatively safe for environmental health. The majority of botanical products contain essential oils, terpenoids and phenylpropanoids, thiophene, amides and alkaloids which slowly weaken the body of the Aedes aegypti mosquito as a dengue vector (28).

Conclusion

Based on the results of research and discussion on the Relationship between Rainfall and Dengue Hemorrhagic Fever (DHF) Cases in West Java Province 2014 - 2020, it is known that there is a relationship between rainfall and DHF cases in West Java Province 2014 - 2020 with a moderate correlation strength where rainfall gives a role to the incidence of DHF cases but is not absolute because it can still be influenced by other factors such as temperature, humidity and air temperature factors as well as a positive direction which means that the increase in the number of DHF cases goes hand in hand with an increase in rainfall.

Researchers suggest to the public to stay alert to dengue hemorrhagic fever, especially when rainfall increases. Always clean the stagnant area and maintain the body's immunity. For Puskesmas, researchers hope that Puskesmas can provide in-depth counselling to the community to be aware of DHF by teaching prevention of DHF disease and teaching a clean and healthy lifestyle. For further research, the

researcher suggests for further research to use other variables so that a strong correlation can be found between DHF and its precipitating factors.

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