



MAP OF TUBERCULOSIS INCIDENCE IN WEST JAVA PROVINCE IN 2023

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ABSTRACT

Indonesia has various infectious diseases, one of which is tuberculosis. This disease is caused by a pathogenic agent, namely the bacteria *Mycobacterium tuberculosis*, which can cause primary symptoms such as a continuous cough. West Java Province is ranked first in the most TB cases in Indonesia, with a total of 203,226 cases in 2023. This study aims to map the spread of the disease by describing the distribution of tuberculosis cases and mapping the level of vulnerability through tuberculosis risk factors. The method used is a descriptive research on the Geographic Information System (GIS) approach with scoring techniques. The data used is in the form of secondary data from the official website (open data access) of the Central Statistics Agency (BPS) of West Java Province. After the collection of variable data from BPS, it is then analyzed with shapefile spatial data through the QGIS program software. The results of this study show that of the 27 districts/cities in West Java Province, there are 2 areas, namely Bogor Regency and Bekasi City, which have a very high level of vulnerability. This vulnerability overview is expected to be the government's initial step in efforts to control and prevent tuberculosis incidents through case detection, strengthening TB prevention programs and establishing cross-sectoral cooperation related to TB incidence, especially in high-risk areas.

Keywords: geographic information system; MAP; tuberculosis; vulnerability; west java

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INTRODUCTION

Tuberculosis, commonly known as TB, is a preventable and curable disease. However, by 2023, TB is likely to return to being the leading cause of death worldwide, having been replaced by coronavirus disease (COVID-19) for 3 years and TB is the disease that causes almost twice as many deaths from HIV/AIDS. About a quarter of the global population is estimated to have been infected with TB. By 2024, 193 countries and territories (out of 215) with more than 99% of the world's population have reported TB cases. Most of the increase in incident cases in the world was between 2022 and 2023. TB incidence (new cases per 100,000 population) in 2023 was 134, a very small increase (0.2%) compared to 2022. Most of the people affected by TB disease each year are in the 30 countries with a high TB burden, which accounts for 87% of the global total in 2023. Five countries account for 56% of the global total: India (26%), Indonesia (10%), China (6.8%), the Philippines (6.8%) and Pakistan (6.3%). People affected by TB in 2023 are 55% men, 33% are women, and 12% are children and young adolescents (World Health Organization, 2024).

Indonesia is a tropical country that has various infectious diseases, one of which is tuberculosis. In 2023, the incidence of tuberculosis in Indonesia is expected to reach 1.09 million, or 387 cases per 100,000 population. The number of TB-HIV cases is 25,000 per year, or 8.8 per 100,000 population. Deaths from TB are estimated at 125,000 (44 per 100,000 population) and deaths from TB/HIV are estimated at 6,200 (2.2 per 100,000 population). The estimated incidence of tuberculosis in 2022 is 9% higher than in 2021 of 1,060,000 and in 2023 is 3% higher than in 2022 of 1,090,000. In addition, the death rate due to tuberculosis decreased by 7% in 2022 to 134,000 and in 2023 to 125,000 (Direktorat Jenderal Pencegahan

dan Pengendalian Penyakit, 2024). Meanwhile, the province with the highest prevalence of TB according to the 2023 Indonesian Health Survey (SKI) data, namely West Java Province ranks first followed by East Java and Central Java. These three provinces have more population density and are therefore more at risk of TB infection than areas with fewer populations (BKPK Kemenkes RI, 2023).

Tuberculosis is caused by a pathogenic agent, *Mycobacterium tuberculosis*, which is a causative agent that has been present in humans for thousands of years and has become one of the major topics in common diseases in the world. The main symptoms of TB are persistent coughing until they are not noticed, as a result of the high rate of disease transmission through droplets or splashes of sputum in the air containing *M. tuberculosis* bacteria. Other symptoms include a raging fever, shortness of breath, decreased appetite, night sweats, and chest pain. The body's immune system will cause a reaction within 6-14 weeks after infection (Kemenkes RI, 2024). Transmission of *M. tuberculosis* occurs after inhaling aerosol droplets containing live bacteria into the human lungs. The success of transmission of these bacteria is influenced by a variety of conditions, including the duration of contact with individuals with active TB disease (Sia & Rengarajan, 2019). Prevention of TB is still a challenge around the world, because this disease is categorized as an infectious disease and has various underlying risk factors such as population density, poor population, sanitation, and so on (Tobin, E.H & Tristram, 2024).

In the event of disease occurrence, both infectious and non-communicable, good region-based disease management is needed to address various underlying risk factors. The incidence of diseases can be attributed to a variety of objects that include spatial phenomena. To support spatial analysis with disease incidence, computer-based Geographic Information Systems (GIS) can be used to determine the distribution of various areas that have risk factors for the occurrence of a disease and to determine disease priority areas that have high vulnerability (Achmadi, 2014). Using GIS can make it easier for stakeholders to make decisions in dealing with disease cases in their work area. Based on various existing problems, the purpose of this study is to map the spread of the disease by describing the distribution of tuberculosis cases and mapping the level of vulnerability through the risk factors of tuberculosis. It is hoped that this research can be useful for related agencies to handle tuberculosis cases in West Java Province, especially to priority areas through their vulnerability level.

METHOD

This research is a descriptive research using the Geographic Information System (GIS) approach to describe the level of vulnerability and determine priority areas in West Java Province in 2023. The data of this study uses secondary data issued from the official website (open data access) of the Central Statistics Agency (BPS) of West Java Province. The data taken are aggregate data to be analyzed, including data on the number of TB cases, poor population (thousand people), population density (per km²), altitude of the region (masl), and the percentage of households with proper sanitation access. This study uses a scoring technique that gives a score in each category or classification in the variable. The spatial analysis units used were 27 districts/cities in West Java Province and data analysis using the QGIS (Quantum Geographic Information System) program. The mapping table in the level of vulnerability to tuberculosis in West Java Province in 2023 is as follows:

Table 1.
Mapping the Vulnerability of Tuberculosis Incidence in West Java Province in 2023

No.	Regency/City	TB cases (1)	Population Density (2)	Poor Population (3)	Sanitation Is Feasible (4)	Altitude of the Region (5)	$\Sigma(1+2+3+4+5)$	Level Vulnerability
1.	Kuningan Regency	2	1	2	1	2	8	Low
2.	Ciamis Regency	1	1	1	2	4	9	Medium
3.	Sumedang Regency	1	1	2	2	3	9	Medium
4.	Bandung Barat Regency	2	1	2	3	1	9	Medium
5.	Pangandaran Regency	1	1	1	1	5	9	Medium
6.	Banjar City	1	1	1	1	5	9	Medium
7.	Tasikmalaya Regency	2	1	2	3	3	11	Medium
8.	Majalengka Regency	2	1	2	1	5	11	Medium
9.	Purwakarta Regency	2	1	1	2	5	11	Medium
10.	Cimahi City	2	5	1	2	1	11	Medium
11.	Garut Regency	4	1	3	3	1	12	Medium
12.	Indramayu Regency	2	1	3	1	5	12	Medium
13.	Subang Regency	3	1	2	1	5	12	Medium
14.	Sukabumi City	2	4	1	3	2	12	Medium
15.	Tasikmalaya City	2	3	1	3	3	12	Medium
16.	Cianjur Regency	4	1	3	2	3	13	High
17.	Bandung Regency	5	2	3	2	1	13	High
18.	Karawang Regency	5	1	2	1	5	14	High
19.	Cirebon City	2	5	1	1	5	14	High
20.	Cirebon Regency	4	2	3	1	5	15	High
21.	Depok City	3	5	1	1	5	15	High
22.	Sukabumi Regency	5	1	2	3	5	16	High
23.	Bekasi Regency	5	2	3	1	5	16	High
24.	Bogor City	4	5	1	2	4	16	High
25.	Bandung City	5	5	2	3	1	16	High
26.	Bekasi City	5	5	2	1	5	18	Very High
27.	Bogor Regency	5	1	5	2	5	18	Very High

Based on table 1, distribution of vulnerability level mapping in the incidence of tuberculosis in West Java Province in 2023 are obtained. The results were adjusted from the determination of the tuberculosis incidence score in the variable. The scoring for the variables of tuberculosis cases, population density, and the number of poor people was categorized into 5, namely very low (1), low (2), medium (3), high (4), and very high (5). The score means that the higher the number of each variable, the higher the score value. Meanwhile, the variables of households with proper sanitation and altitude of the region are categorized into 5, namely very low (5), low (4), medium (3), high (2), and very high (1). The score means that the lower the number of each variable, the higher the score value. The determination of the score is considered with the problems in each variable and becomes a cut point in data analysis.

RESULT

Distribution of Tuberculosis Incidence in West Java Province in 2023

In 2023, West Java Province has 203,226 cases. Based on Figure 1, it is divided into 5 categories, namely very high ($>10,400$ cases), high (7,901-10,400 cases), medium (5,401-7,900 cases), low (3,401-5,400 cases), and very low ($\leq 3,400$ cases). The areas with very high cases are marked by the darkest color which is 7 regions, namely Bogor Regency, Bandung City, Bekasi City, Karawang Regency, Bandung Regency, Bekasi Regency, and Sukabumi Regency. Meanwhile, tuberculosis cases are very low marked by white in 4 regions, namely Pangandaran Regency, Banjar City, Ciamis Regency, and Sumedang Regency.

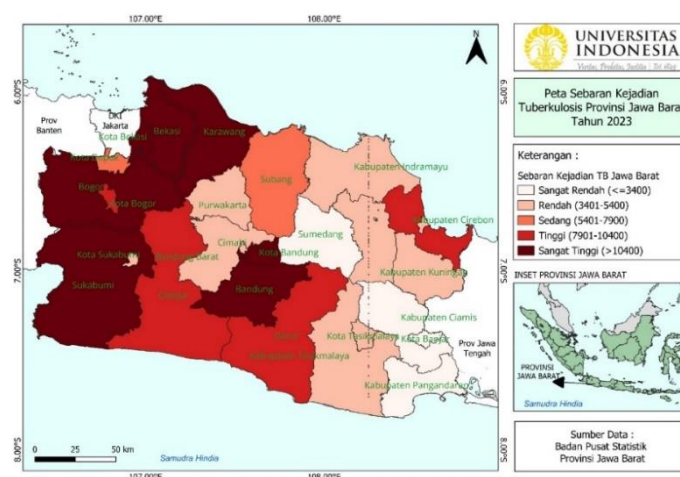


Figure 1. Distribution Map of Tuberculosis Incidence in West Java Province in 2023

Distribution of Tuberculosis by Population Density in West Java in 2023

Based on Figure 2, it is categorized into 5 parts, including very high ($>8,000$ per km²), high (6,001-8,000 per km²), medium (4,001-6,000 per km²), low (2,001-4,000 per km²), and very low ($\leq 2,000$ per km²). Areas with darker colors are characterized by higher population density. There are 6 areas with a very high population density, namely Bandung City, Cimahi City, Bekasi City, Depok City, Bogor City, and Cirebon City. Meanwhile, there are 16 districts/cities in West Java Province with a very low population density. It can be known that the population density is very high in the municipal area while the population density is very low spread across almost all areas in West Java Province.

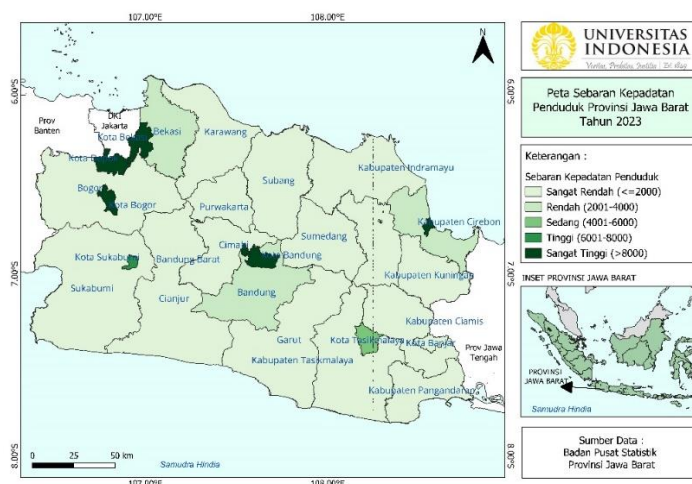


Figure 2. Population Density Distribution Map of West Java Province in 2023

Distribution of Tuberculosis by Poor Population in West Java Province in 2023

Based on figure 3, 5 parts are categorized, including very high (>400 thousand people), high (301-400 thousand people), medium (201-300 thousand people), low (101-200 thousand people), and very low (≤ 100 thousand people). However, the results were obtained based on the poor population in only 4 categories. Areas with darker colors are characterized by a higher number of poor people. The area with a very high poor population is only in Bogor Regency. Meanwhile, the poor population in the very low category is 10 regions, namely Banjar City, Sukabumi City, Cimahi City, Cirebon City, Pangandaran Regency, Depok City, Bogor City, Tasikmalaya City, Purwakarta Regency, and Ciamis Regency.

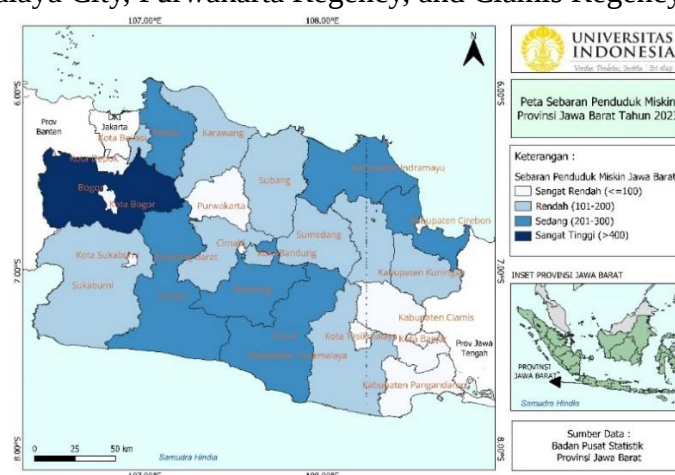


Figure 3. Map of the Distribution of the Poor in West Java Province in 2023

Distribution of Tuberculosis Based on Households with Proper Sanitation in West Java Province in 2023

Based on figure 4, 5 parts are categorized, including very high (>80), high (61-80), medium (41-60), low (21-40), and very low (≤ 20). However, results were obtained based on households with proper sanitation in only 3 categories. Areas with darker colors are characterized by more and more households having access to proper sanitation. However, the more faded the color of the region, the lower the level of households that have access to proper sanitation. The results of the medium category were obtained in 7 regions, namely Sukabumi City, Tasikmalaya Regency, Sukabumi Regency, Garut Regency, Bandung City, Tasikmalaya City, and West Bandung Regency.

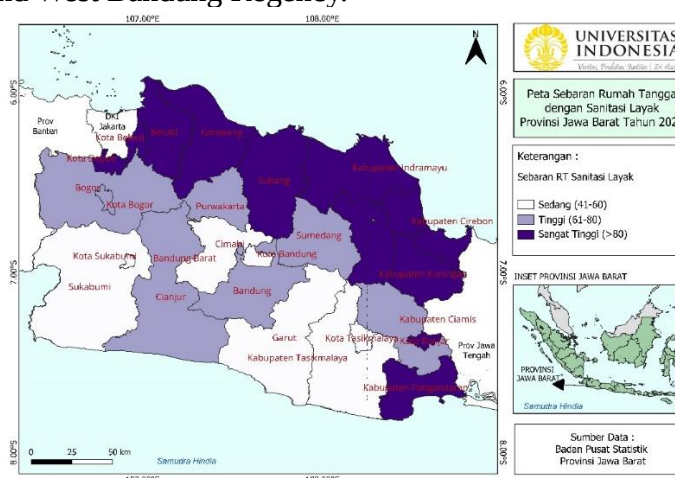


Figure 4. Distribution Map of Households with Proper Sanitation in West Java Province in 2023

Distribution of Tuberculosis Based on Altitude of the Region in West Java Province in 2023

Based on figure 5, 5 parts are categorized, including very high (>640 masl), high (481-640 masl), medium (321-480 masl), low (161-320 masl), and very low (≤ 160 masl). Areas with fainter colors have lower regional heights compared to areas with darker colors. The results of the distribution of almost all areas at the altitude of the region with a very low category were obtained. There are 14 districts/cities that have very low regional heights. Meanwhile, the height of the very high category area has 5 adjacent districts/cities.

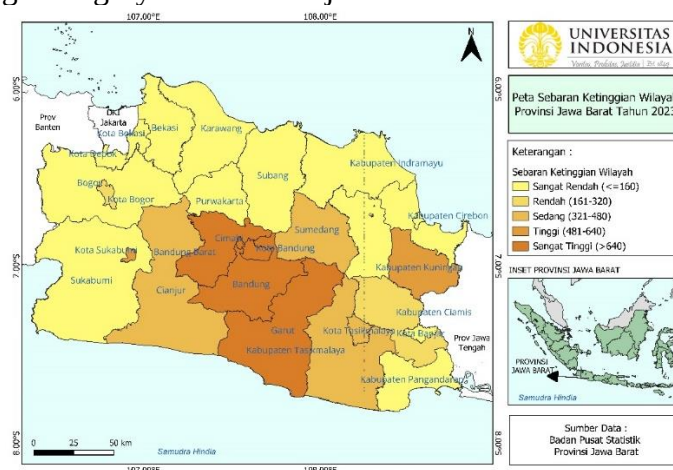


Figure 5. Map of the Distribution of Altitude of the Region in West Java Province in 2023

Distribution of Tuberculosis Incidence Vulnerability in West Java Province in 2023

Based on figure 6, the results of determining the priority of the tuberculosis incidence area from the total between scores of each risk factor and tuberculosis incidence are determined. On the vulnerability map, 4 categories of levels are obtained from 5 levels. The results show that there are 2 districts/cities, namely Bogor Regency and Bekasi City, which have a very high level of vulnerability marked with dark purple, followed by 10 districts/cities with a high level of vulnerability in light purple, 14 districts/cities with a medium level of vulnerability marked in blue, and one area, namely Kuningan Regency which has a low level of vulnerability in light blue. The total determinants of tuberculosis incidence in each district/city are prioritized by the region through very low, low, medium, high, and very high levels of vulnerability.

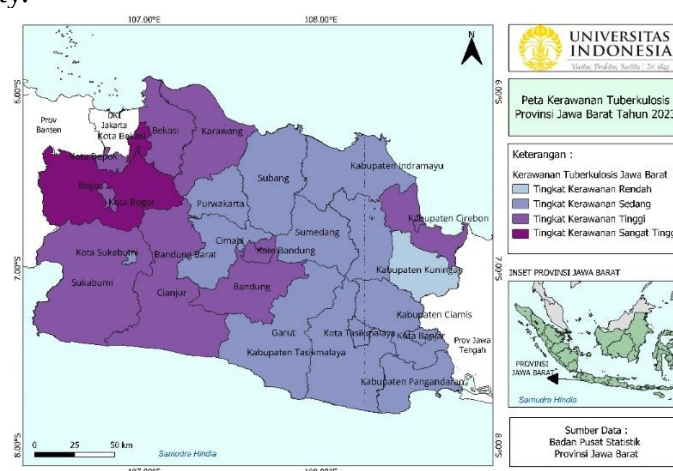


Figure 6. Tuberculosis Vulnerability Map of West Java Province in 2023

DISCUSSION

Some of the efforts that have been made by the province of West Java according to the Governor of West Java Regulation Number 12 of 2019 concerning the Regional Action Plan for Regional Tuberculosis Control in West Java Province for 2019-2024 include the involvement of people affected by TB prevention, education, advocacy, and assistance to the community through the facilities provided, and conducting periodic monitoring and evaluation (Pemerintah Daerah Jawa Barat, 2019). Efforts to handle TB cases are case detection and drug administration for 6 months. This program can help reduce the rate of illness and death and reduce discrimination for sufferers. This effort is one of Indonesia's targets in handling tuberculosis cases (Humas Jabar, 2024). Through the distribution of the vulnerability map of tuberculosis incidence in West Java, it can help as an overview of regional priorities that must be addressed immediately in this TB case.

According to the West Java Health profile from 2021, 85,681 cases were reported and the 3rd highest cases were found in Bogor Regency, Bandung City, and Bandung Regency. In 2022, it was reported to have increased from the previous year, namely 160,661 cases and the highest cases were in Bogor Regency, Bandung City, and Bekasi City. In 2023, it was reported that TB cases increased by 31.9% with the highest cases in Bogor Regency, Bandung City, and Bekasi City (Dinas Kesehatan Provinsi Jawa Barat, 2023). This is in line with this study that the position of the three highest cases is in the areas of Bogor Regency, Bandung City, and Bekasi City. From these findings, it is associated with the determinants of population density, poor population, households with proper sanitation, and area height. Bekasi City is one of the areas with a very high population density in West Java Province, which is 12,332 per km² and is categorized as very high in the incidence of TB. This is in line with Suryani's research that the higher chance of the risk of TB incidence is obtained from population density, which is 1,889 times (Suryani & Ibad, 2022). Very high population density can accelerate person-to-person transmission, thus proving that densely populated areas with high category levels have a high number of TB cases as well (Srisantyorini et al., 2022). Population density can exacerbate social vulnerabilities in communities such as lack of good environmental sanitation, inadequate housing, high burden on health services, congested public transportation, and others that can potentially be the cause of an increase in tuberculosis cases. Population density can also increase the likelihood of TB infection and transmission in communities (Liyew et al., 2024). TB transmission occurs through airborne particles (droplets) containing *Mycobacterium tuberculosis* (MTB). Droplets are 1 µm to 5 µm in size, produced by individuals who have TB when they cough, sneeze, or talk (Swaminathan et al., 2021).

The distribution of the number of poor people with a very high category is in areas that have very high cases as well, for example in Bogor Regency as an area that has the largest number of poor people compared to other regions. This is in line with Madao's research that there is a positive correlation between the number of poor people and TB cases in West Java Province in 2022 (Emilia Pandin Madao et al., 2024). Low-income residents tend to prioritize food needs over disease prevention such as routine health checks, vaccinations, and personal hygiene products. In addition, there is a lack of purchasing power for nutritious food, resulting in weak immunity in the body. Therefore, this results in more infectious diseases suffered by low-income residents compared to high-income residents (Sarjito, 2024). Sanitation is a necessity that must be had, because sanitation is a form of effort to prevent all risk factors from the environment that can cause the spread of disease in the community. As in Meriyanti's study, it was stated that there was a relationship between home sanitation and the incidence of tuberculosis in the Denpasar City area, this result was adjusted to several risk factors, namely temperature, humidity, lighting, occupancy density, and ventilation (Tria Meriyanti & Sudiadnyana, 2018). Of the 7 districts/cities of West Java Province with the medium category,

the number of TB cases varies from very high to low. This depends on other factors that can affect the number of cases. With the condition of the house that has access to proper sanitation, it can play an important role in reducing and preventing the transmission of diseases, especially infectious diseases.

Areas with very low regional altitude have TB cases in the very high category, in the sense that the altitude of the region affects the incidence of TB. This is in line with Hartanto's research, namely the distribution of TB incidence is often found in low-lying areas, namely ≤ 150 meters above sea level (Hartanto, T. D., Saraswati, L. D., Adi, M. S., & Udiyono, 2019). The same thing with Corbett's research states that observations over the past 110 years have been obtained that Tibetans and Nepalese are at higher risk of developing tuberculosis when immigrating to the lowlands (Corbett et al., 2022). West Java Province has various areas including steep mountains in the southern region with an altitude of $>1,500$ meters above sea level, the central area of the hills slopes 100-1,500 meters above sea level, the northern region has an area of 0-10 meters above sea level, and a river basin area (Badan Pusat Statistik Provinsi Jawa Barat, 2024). Environmental factors can support the sustainability of the spread of disease transmission. Generally, bacteria from *Mycobacterium tuberculosis* can grow at a temperature of 37°C , while the average temperature in West Java Province is $25\text{-}30^{\circ}\text{C}$. Therefore, temperature can affect the spread of bacteria in the environment (Riznawati et al., 2024).

The mapping of the vulnerability level of tuberculosis cases in West Java Province in 2023 was obtained from 27 districts/cities, there are 2 areas with very high levels of vulnerability. Bogor Regency and Bekasi City are priorities for West Java Province in an effort to control TB. This is different from the research of Novitasari and Inggarputri which obtained 5 priority areas including the city of Bandung, Purwakarta Regency, Cianjur Regency, Bandung Regency, and West Bandung Regency (Novitasari, P.D., & Inggarputri, 2023). The difference is due to the risk factors studied and the year of TB incidence in West Java Province. Bogor Regency is an area with very high vulnerability which is supported by the number of TB cases, low-lying areas, and a high number of poor people. However, it has a low population density and households that have high sanitation rates. The thing that is slightly different from Bekasi City is that it has a very high population density and a low number of poor people.

CONCLUSION

The geospatial information system approach as carried out in this study can be used as a way to see the picture of the spread of diseases at the population level, environmental conditions both physical and social. The existence of aspects such as the number of TB incidences, population density, the number of poor people, the number of households with proper sanitation, and the height of the area in West Java Province in 2023 resulted in a mapping of vulnerability obtained in 4 categories including low, medium, high, and very high. Based on the results of this study, it was concluded that there are 2 areas out of 27 districts/cities in West Java Province, namely Bogor Regency and Bekasi City with a very high level of vulnerability category. Aspects that can affect the high incidence of tuberculosis in an area can be used as input to the provincial government for tuberculosis control and prevention measures. Steps that can be taken include case detection, strengthening TB prevention programs and establishing cross-sectoral cooperation related to TB incidence, especially in high-risk areas. This study highlights the distribution of vulnerability in districts or cities in West Java Province from various determinants in TB incidence and makes the picture as the first step for efforts to control and prevent TB incidence.

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