Spatial Analysis of DHF Cases in Yogyakarta City Based on Population Density and Altitude (2017-2018)

Aims: This study aims to determine the relationship between population density and altitude of the territory and DHF incidence in Yogyakarta City in 2017-2018.
Study design: The study was designed as an observational cross-sectional study.
Place and Duration of Study: This study was conducted in Yogyakarta from 2017 to 2018.
Methodology: This quantitative study employs an analytic observational cross-sectional design. Moran's I and LISA tests were used to analyze the data.
Results: Based on bivariate Moran's Scatterplot analysis, the density of residents with dengue incidence showed negative spatial autocorrelation (I=-0.308), and the altitude with dengue incidence showed negative spatial autocorrelation (I=-0.128), indicating that the majority of the sub-district was scattered in quadrants II and IV. The LISA density bivariate test results on residents with dengue incidence revealed that the Gondomanan Sub-district has positive autocorrelation (Ii= 0.30) with a Low-Low quadrant and statistical significance (P-Value=0.040.05). In contrast, Kotagede Sub-district has negative autocorrelation (Ii=-2.31) with a Low-High quadrant and statistical significance (P-Value=0.000.05). Gondomanan Sub-District has positive autocorrelation (Ii=0.67) at the Low-Low quadrant and statistical significance (P-Value=0.03 0.05), whereas Kotagede Sub-District has negative autocorrelation (Ii=-2.86) at the Low-High quadrant and statistical significance (P-Value=0.000.05).
Conclusion: Density residents have a negative autocorrelation with the incidence of DHF in Yogyakarta City. Local spatial density residents with DHF cases were found in the Gondomanan Sub-District with positive spatial autocorrelation. At the same time, Kotagede Sub-District had negative spatial autocorrelation in contrast to an altitude with a global spatial connection toward DHF incidence in Yogyakarta with negative autocorrelation.

Keywords: Population Density, Altitude, DHF Incidence, Yogyakarta

1. INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is an issue spreading throughout Indonesia's provinces. Incidence rate (IR) DHF in Indonesia in 2015 was 50.75 per 100 people, growing to 78.85 per 100 in 2016. The experience fell to 26.10 per 100,000 people in 2017 before declining to 24.75 per 100,000 in 2018 [1]. Yogyakarta Province has an incidence rate (IR) of 43.65 per 100,000 people, which is higher than the national average of 26.12 per 100,000 people, according to the Indonesia Data and Information Center's 2017 report on the situation in Indonesia [2]. Incidence rate (IR) DHF in the Yogyakarta Special Region (DIY) in 2017 was 81.36 per 100,000 population [3].

Yogyakarta City is becoming a DHF-endemic location, according to DHF data from 2018, even though there were 414 cases and two fatalities in 2017 and 113 cases and two deaths in 2018. However, the incidence rate (IR) of DHF increased from the previous year; in 2018, it was 27 per 100,000 people, up from 10 per 100,000 people in 2017. Additionally, rising the prior year, the DHF

Case Fatality Rate (CFR) was 1.8 percent in 2018 compared to 0.5 percent in 2017 [4]. Dengue transmission in a crowded place spreads more rapidly because of the density of residents, the higher risk of transmission caused by dengue fever, and the distance between 50-100 meters. Residents' density is divided into three categories: low (1000 people/km2), moderate (1,000–2,000 people/km2), and high (>2000 inhabitants/km2) [5]. Yogyakarta City has a population density of (14,350 people/km2), which is a possible danger for dengue illness transmission.

Aedes aegypti mosquito may live at a height of 100 meters above sea level. Aedes Aegypti's deployment is constrained to 1000–1500 meters above sea level in Southeast Asia [6]. Given that Yogyakarta City is generally 128.5 meters above sea level, it follows that there is a chance that dengue cases could spread there. This study aims to comprehend the relationship between population density and altitude of the area where dengue hemorrhagic fever (DHF) incidents occur in the City of Yogyakarta.

2. METHODOLOGY

This quantitative study uses an analytic observational and *cross-sectional* design in which every object is observed once at a particular time [7]. The Yogyakarta City Health Profile for 2018–2019, Yogyakarta City in Figures for 2018–2019, and regional elevation data based on the City of Yogyakarta in Figures for 2020 were utilized to generate the study's data. This study uses both spatial univariate and spatial bivariate data analysis. Total sampling was used as the retrieval technique sample in this study. Total sampling is a measurement method in which the entire population is used as a sample [8]. People being studied The Yogyakarta City Health Profile 2018-2019 contains data on all DHF cases in the locality from 2017 to 2018.

3. RESULTS AND DISCUSSION

A. Univariate Spatial Analysis

The fourth quantile (highest) incident of dengue hemorrhagic fever extended in the Gondokusuman and Umbulharjo subdistricts. In contrast, the Pakualaman and Danurejan Sub-District experienced the lowest dengue incidence rates (Figure 1).

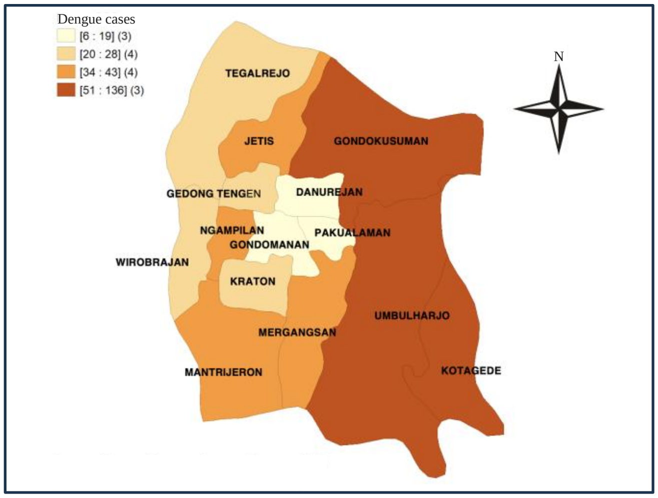

Figure 1. Distribution of Dengue Hemorrhagic Fever in Yogyakarta City

The Ngampilan, Gedongtengen, and Danurejan Sub-District have the most prominent density residents (4th quantile). As opposed to this, the Umbulharjo, Gondokusuman, and Kotagede Sub-District had the highest density of residents in the first quantile (lowest) (Figure 2).

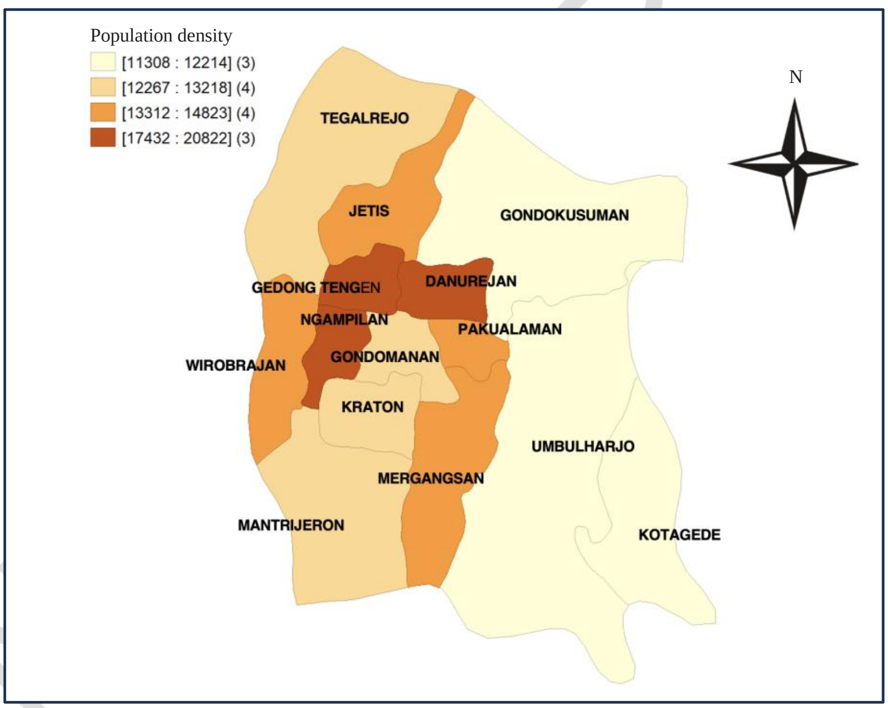

Figure 2. Distribution of Population Density in the Yogyakarta City

The highest altitude area covered the Danurejan, Gedongtengen, and Pakualaman Sub-District. In contrast, the Gondomanan and Kotagede Sub-District was the altitude area with the first quantile's (lowest) distribution (Figure 3)

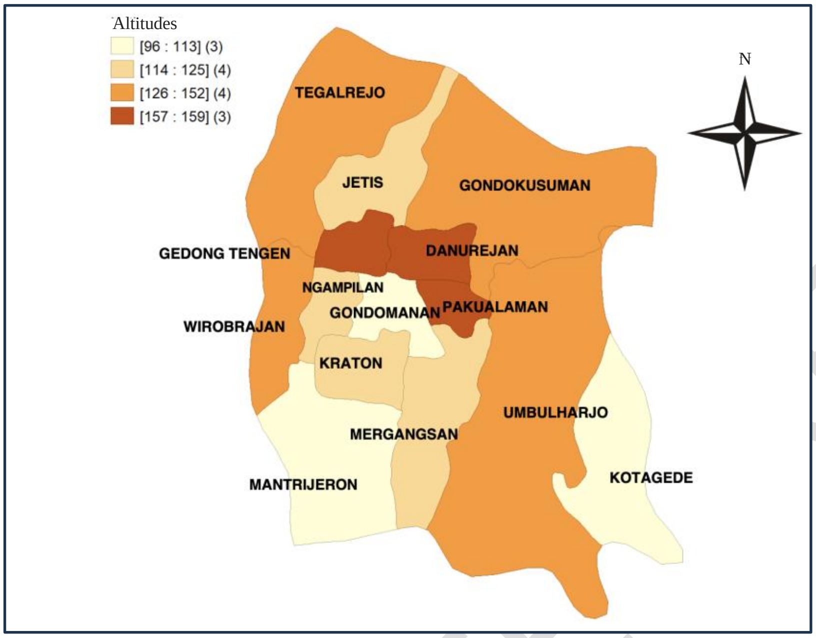

Figure 3. Distribution Regional Altitude in the City of Yogyakarta

B. Bivariate Spatial Analysis

According to the findings of the bivariate test, the Moran's Scatterplot between altitude and population density has a negative spatial autocorrelation or is inversely proportional to the incidence of dengue fever (Moran's I= -0.128) and (Moran's I=-0.308) for altitude and population density respectively (Figure 4 and 5).

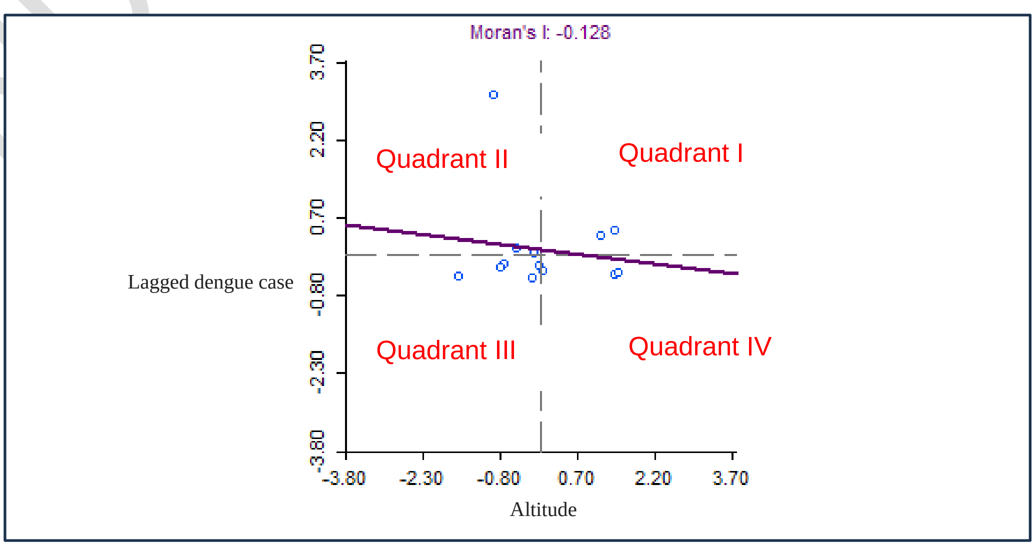

Figure 4. *Moran's Scatterplot* Altitude with Dengue Case

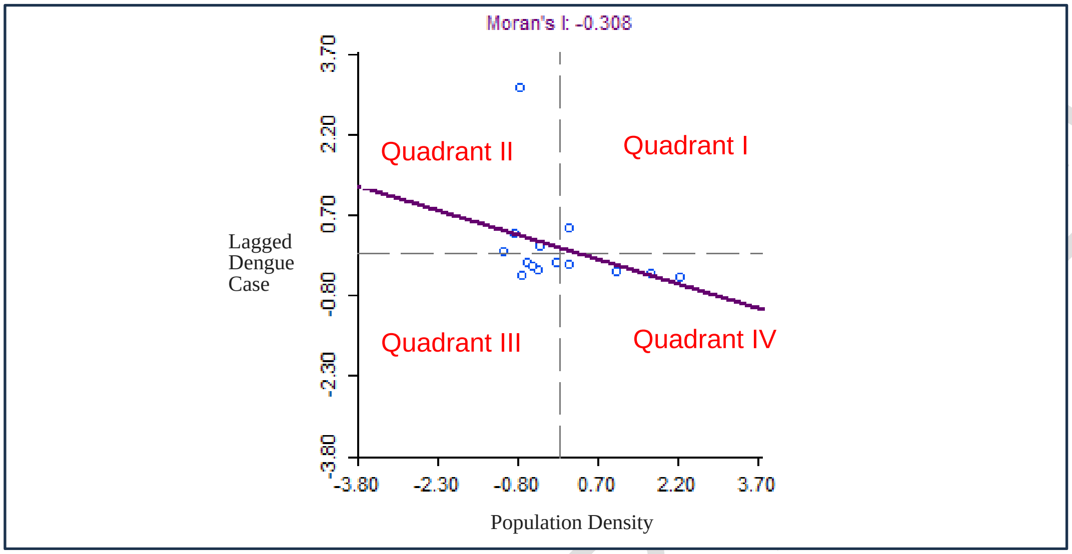

Figure 5. *Moran's Scatterplot* Population density with Dengue case

Based on the LISA bivariate test between density residents with incident dengue hemorrhagic fever showed that Gondomanan and Kotagede Sub-District own (*P-Value* ≤ 0.05), thus H_0 is rejected, which means significant or has spatial autocorrelation, the Gondomanan Sub-District showed positive autocorrelation (*li*= 0.30), is in the quadrant *Low-Low* (LL) and significant at (*P-Value* = 0.04 ≤ 0.05), which indicates that low-density residents in Gondomanan Sub-District own spatial connection to low number dengue incidence in the around Gondomanan Sub-District (*neighbors*). While, Kotagede Sub-District has negative autocorrelation (*li* = -2.31), placed in *Low-High* (LH) quadrant and significance at (*P-Value* = 0.00≤0.05), which indicates that low-density residents in Kotagede Sub-District and own spatial connection to number dengue incidence in the location around Kotagede Sub-district (*neighbors*) (Figure 5).

According to the findings of the spatial Moran's I bivariate analysis of the variable's density resident and dengue incidence, density residents have a negative spatial autocorrelation (Moran's I=-0.308) or a reverse association with dengue incident. Based on the spatial LISA bivariate analysis findings on the variable's density of residents with dengue incidence, the Gondomanan and Kotagede Sub-District had a robust spatial link. The sub-district with the lowest density of residents is surrounded by the sub-district with the lowest incidence of DHF, which means that the sub-district with the lowest density of residents has a spatial relationship with the sub-districts with the lowest number of dengue incidence in the vicinity (P-Value=0.040.05). Gondomanan Sub-District has a low population density, while Danurejan and Pakualaman Sub-District and the sub-districts nearby have low dengue incidence rates.

Meanwhile, Kotagede Sub-District showed the spatial connection density resident with the incidence of DHF (P-Value=0.00≤0.05) with adequate connection and negative directed (li = -2.31) placed in Low-High quadrant (a district with density resident low surrounded subdistrict with number high incidence of DHF), meaning low-density residents in Kotagede Sub-District own spatial connection to height number dengue incidence in the area around Kotagede Sub-District. Kotagede Sub-District has a lower population density than Umbulharjo and Gondokusuman Sub-Districts, which have higher dengue prevalence.

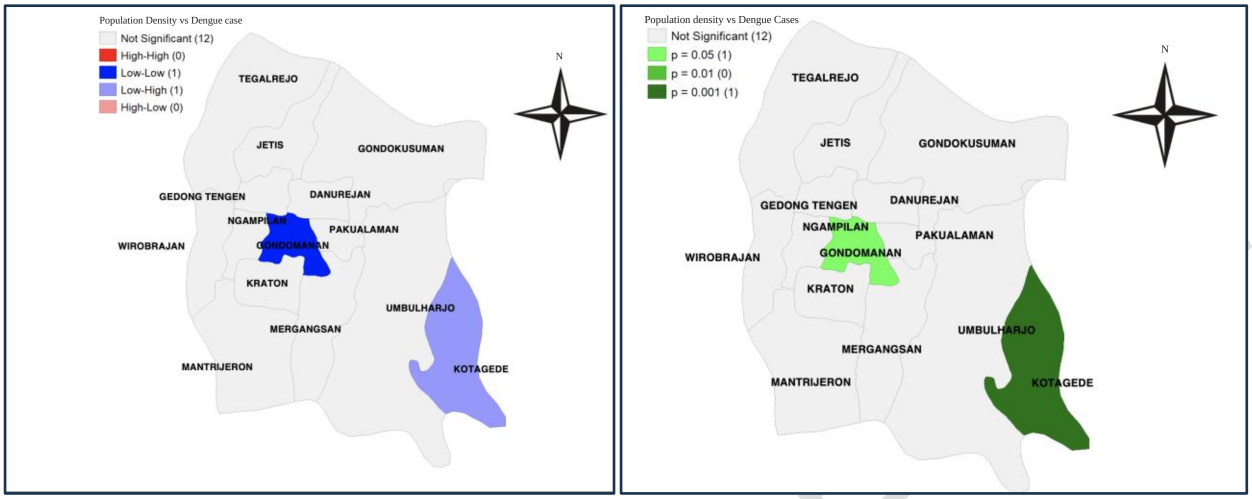

Figure 6. LISA Density Bivariate Significance Test and Cluster Between Population Density and Dengue Case

Based on LISA bivariate test results between altitude area with incident DHF showed that Gondomanan Sub-District and Kotagede Sub-District own (*P-Value* ≤ 0.05), that stands for H_0 is rejected which means significant or has spatial autocorrelation spatial toward the sub-district. Gondomanan Sub-District has positive autocorrelation (*li* = 0.67), and the *Low-Low* (LL) quadrant has significant at (*P-Value* = 0.03 ≤ 0.05), which indicates that the low height of Gondomanan Sub-District owns spatial connection to low number dengue incidence in the area around Gondomanan Sub-District (*neighbors*). While, the Kotagede Sub-District has negative autocorrelation (*li*=-2.86), placed in the *Low-High* (LH) quadrant with significance at (*P-Value*=0.00≤0.05), which indicates the low height of the area in the Kotagede Sub-District has a spatial connection to number dengue incidence in the area around Kotagede Sub-District (neighbors) (Figure 6).

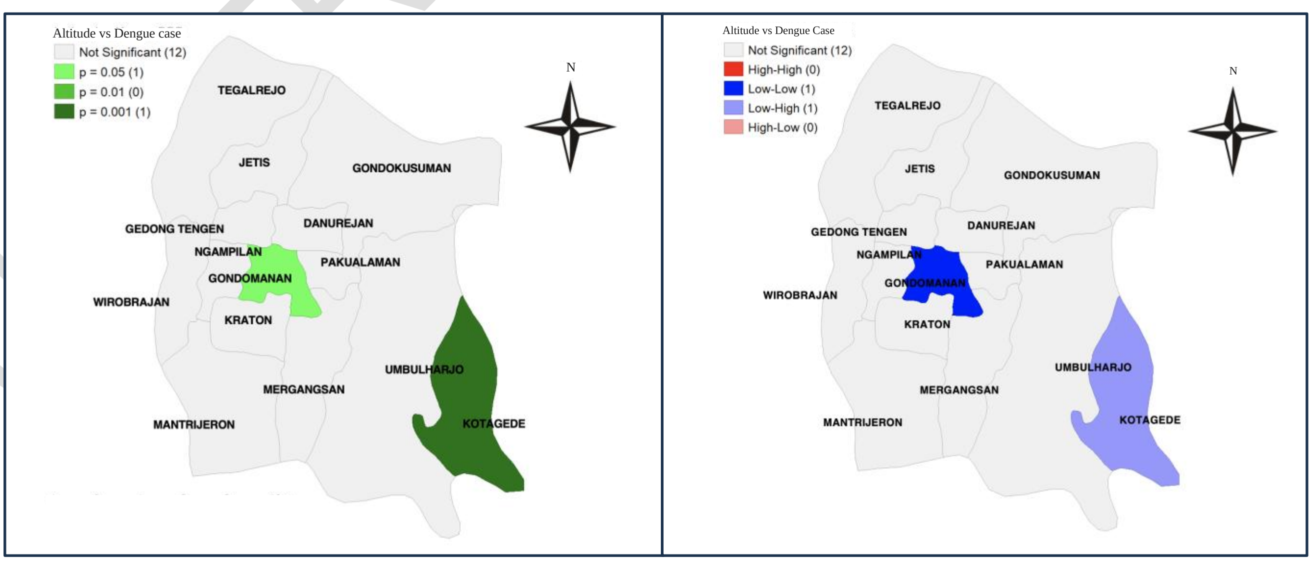

Figure 7. LISA Altitude Bivariate Test Significance Map with Dengue Incident

Since mosquitoes can travel up to 50 meters in the air, this is where dengue fever could spread. There is a higher chance of dengue fever transmission in heavily populated places [8]. According to previous research, the relationship between resident density and DHF is modest and positively directed (r = 0.13); the higher the resident density, the more dengue incidents there were [9]. Like that study, Biis & Sukesi (2017) discovered a weak, positively directed link between the density of residents and DHF (r = 0.336). It shows that the number of dengue incident cases increases with resident density [10]. Our results in the Gondomanan Sub-District are consistent with the findings of these two studies, but the Kotagede Sub-District shows different results.

Since altitude affects air temperature and humidity, which in turn affects the development of vector mosquitoes and dengue viruses, altitude is a crucial component that might affect the existence of vector mosquitoes [11]. In a region with an altitude of more than 1,000 masl, no dengue mosquitoes are found, hence, the risk of getting infected with dengue is low [12]. Increasing altitude in a particular area will cause a standard temperature change [13]. Based on spatial Moran's I, bivariate analysis on altitude variables showed that the altitude area has negative spatial autocorrelation (*Moran's I*=-0.128) or inversely with dengue incident. Based on the results, spatial LISA bivariate analysis on altitude area variables with dengue incidence shows that two significant areas have spatial connections, including the sub-district Gondomanan and Kotagede Sub-District. The Gondomanan Sub-District shows that spatial association between altitude area and the incidence of DHF (*P-Value* = 0.03) with adequate connection and positive directed (*Ii*=0.67) in quadrant *Low-Low* quadrant (district with low altitude area surrounded sub-district with number low incidence of DHF), meaning altitude in the Gondomanan Sub-District has spatial connection to low number of dengue incidence in the area around Gondomanan Sub-District. Gondomanan Sub-District has a low altitude area, and the sub-districts located around Gondomanan Sub-District are Pakualaman and Danurejan Sub-District; they have a low incidence of dengue.

Meanwhile, Kotagede Sub-District shows the spatial connection (*P-Value* = 0.00 ≤ 0.05) with adequate connection and negative direction (*Ii*=-2.86) in *the Low-High* quadrant (area with low altitude area surrounded sub-district with number high incidence of DHF), meaning low altitude in Kotagede Sub-District owns spatial connection to number dengue incidence in the sub-district around Kotagede Sub-District. Kotagede Sub-District owns a low altitude area, and the sub-districts located around Kotagede Sub-District, such as Umbulharjo and Gondokusuman Sub-District, have high incidence amount of dengue. Research from Tamengkel *et al*. (2020) shows that the connection between altitude area and DHF (*P-Value*=0.001<0.05) has a weak link and negative directional (r=-0.295), the highest altitude the lowest dengue incident [6]. Likewise, a study by Paomey *et al*. (2019) shows a larger scale of DHF cases occurred with the low plain category (49 cases), moderate plains category (23 cases), and high plains category (12 cases) [14]. Our result shows that the Kotagede Sub-district has similar findings to this previous research but different results found in the Gondomanan Sub-district. The rising temperature impacted ecosystem degradation and mosquito reproduction. From the altitude area, Gondomanan is a sub-district with the lowest elevation area in the city of Yogyakarta (96 masl) and less than 1,000 meters above sea level, which limits the deployment of vector mosquitoes in Southeast Asia. Altitude 1,000-1,500 meters above sea level is the limit for deployment of mosquito *Aedes aegypti*. However, it is still possible for Aedes to live in the region with an altitude > 1,000 meters above sea level. A temperature of around 25^0 -27^0 C is suitable for breeding mosquitoes to increase DHF cases [15][16]. The average temperature in Yogyakarta in 2017 was 26.05^0 C. In 2018, it was 26.00^0 C, which means the development of breeding vector mosquitoes and the spread of the dengue virus can increase dengue cases [17] [18].

5. CONCLUSION

There is a positive spatial autocorrelation between population density and dengue fever incidence in Gondomanan Sub-District and a negative spatial autocorrelation in Kotagede Sub-District. With a negative autocorrelation, regional altitude has a global spatial relationship with the incidence of dengue fever in Yogyakarta City. Locally, there is a positive spatial autocorrelation between restricted height and the incidence of dengue fever in the Gondomanan Sub-District and a negative spatial autocorrelation in the Kotagede Sub-District. We recommend that local authorities provide sufficient education to residents that population density is related to dengue transmission. Apart from that, environmental cleanliness through the movement to clean mosquito nests must be reactivated after the pandemic.

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