Spatial Distribution of Free Larvae Index (Fli) to Dengue Hemorrhagic Fever (Dhf) Cases In 2020-2022 in Sememi Health Center Surabaya

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Abstract. The Sememi Health Center in Surabaya City reported the highest number of dengue cases in 2020. Control measurement on the dissemination of DHF has been implemented to perceive the outcome of controlling it, which can be assessed through the Free Larvae Index (FLI) indicator in larvae surveys. This research aims to analyze the spatial FLI of DHF cases in 2020-2022 in Sememi Health Center Surabaya. This research employs a descriptive-analytic approach with a cross-sectional design and utilized GIS application. Secondary data on FLI and DHF cases at the Sememi Health Center were used as research variables. The research sample was obtained through a total sampling, whereas to determine the effect of FLI on DHF cases used mapping application to analyze the data. The distribution pattern of DHF cases is clustered with Average Nearest Neighbor value = 0,54. The result of the Moran's Index (I) analysis showed a value of 0,202, which means that there is a relationship between FLI and DHF cases in the Sememi Health Center Surabaya. Spatial analysis with SIG is useful for knowing the relationship between geographical location and the incidence of infectious diseases, beside that it can help in overcoming dengue cases in an area. it is necessary to socialize the eradication of mosquito nests, improving environmental sanitation and public places by involving health center to minimize the presence of larvae.

Keywords: FLI, DHF, Spatial Analysis

1 Background

Dengue Hemorrhagic Fever (DHF) is an illness caused by the dengue virus, which is transmitted from person to person through the bite of Aedes mosquitoes [27]. The primary vectors responsible for transmission are Aedes aegypti and Aedes albopictus mosquitoes [6, 13]. Research conducted by Massaid et al. indicates that Java Province has the highest number of deaths due to dengue fever, primarily attributed to its high population density of 126.403 people. This study also underscores that the incidence of dengue cases tends to rise in tandem with increasing population density since a larger population facilitates faster virus transmission [17].

T. Triwiyanto et al. (eds.), *Proceedings of the 6th International Conference of Health Polytechnic Surabaya (ICoHPS 2023)*, Advances in Health Sciences Research 72,
https://doi.org/10.2991/978-94-6463-324-5_55

Surabaya City was ranked fourth among cities with the highest dengue cases in East Java Province in 2022, with a total number of 111 cases[4]. Sememi Health Center records the highest number of dengue fever cases, specifically 14 cases in 2020[5]. A preliminary study yielded annual dengue fever data from the Sememi Health Center. In 2020, there were 14 reported cases of dengue fever. DHF cases increased in 2021 to 19 cases and further increased in 2022 to 44 cases. The Sememi Health Center in Surabaya City falls into the category of dengue-endemic areas as dengue cases have been consistently reported over the last three years.

The Free Larvae Index (FLI) serves as an indicator assessable during larvae survey activities[1]. FLI is calculaded by dividing the number of houses or buildings without mosquito larvae within a specific time frame by the total number of houses or buildings inspected, and then multiplying the result by 100% [29]. An area is considered larvae free when the FLI value is ≥95%, indicating a low likelihood of dengue transmission [21]. The calculating of FLI mosquito larvae density aims to determine the number of houses that are positive and negative for larvae[19].

The Sememi Health Center Surabaya has not yet conducted a comprehensive spatial distribution analysis of LFI to DHF cases within its operational area. One of the recommended steps prior to implementing prevention and control program planning is to employ spatial analysis of DHF occurrences [14, 25]. Given the challenges in direct community outreach and the limited interest of the community in keeping pace with increasingly sophisticated technological advancements, a Geographic Information System (GIS) has been selected as a toll for assessing DHF spread [22].

2 Research Methods

This research employs a descriptive-analytic approach with a cross-sectional design and utilizes a spatial application approach using GIS. The final output consisted of a map illustrating the distribution of LFI to DHF cases. The study's population included all DHF patients residing in the Sememi Health Center Surabaya operational area, documented in DHF reports from 2020 to 2022, with 76 cases.

The study utilized a total sampling technique to select its samples. The research data encompassed both primary and secondary data sources. Secondary data were collected to obtain LFI data and DHF cases, while primary data were collected through on-site visits to the homes of DHF patients to obtain location coordinates using a Global Positioning System (GPS) device.

The analysis employed in this study is both univariate and spasial. Univariate analysis is employed to elucidate or describe the characteristics of each research variable [26]. Spatial analysis is utilized to ascertain the patterns of disease transmission and identify potential areas for the spread of dengue fever [31]. Spatial analysis in this research utilizes the Average Nearest Neighbor (ANN) and Bivariate Local Morans'I method.

3 Results And Discussion

3.1 Overview of the Research Location

The Sememi Health Center Surabaya is located at 112°38’06” East Longitude and 7°14’55” South Latitude. The service area of the Sememi Health Center Surabaya covers an approximate area of 23,57 km2, with the following boundaries:
Nortern boundary : Madura Strait
Souttern boundary : Sambi Kerep District
Western boundary : Pakal District
Eastern boundary : Tandes District
The service area of the Sememi Health Center Surabaya comprises four sub-districts, as detailed in the Table 1

Table 1. List of Area, Population, and Densities in the Sememi Health Center Surabaya

No	Subdistrict	Area (km^2)	Population Count (individuals)	Population Density	Desciption
1	Sememi	4,18	38.887	9.303 individuals/km2	High population density
2	Kandangan	3,43	22.988	6.702 individuals/km2	High population density
3	Tambak Oso Wilangon	8,46	3.775	446 individuals/km2	Low population density
4	Romokalisari	7,5	2.996	399 individuals/km2	Low population density
	Total	23,57	68.646	16.850 individuals/km2	

Based on Table 1, Tambak Oso Wilangon Village has the largest area, covering 8,46 km2, while Kandangan Village has the smallest area, measuring 3,43 km2. The highest population is in Sememi Village, totaling 38.887 people, while the lowest population is in Romokalisari Village, with a population of 2.996 people.

3.2 Spatial Distribution of Dengue Fever Case from 2020-2022 in Sememi Health Center Surabaya

Data on dengue fever cases for 2020-2022 in Sememi Health center can be seen in Fig. 1 below:

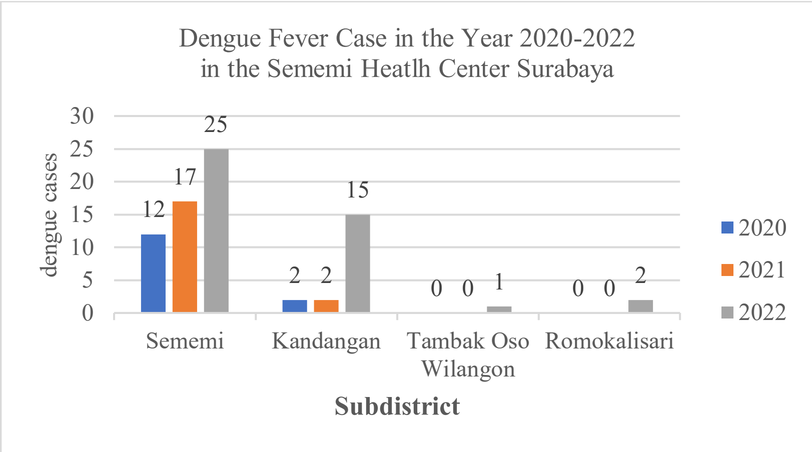


Fig. 1. Dengue Fever Case in the Year 2020-2022 in the Sememi Health Center Surabaya

Fig. 1 displays a total of 76 dengue cases recorded from 2020-2022. Sememi village consistently reported the highest number of cases each year. In contrast, the lowest dengue fever cases were observed in Tambak Oso Wilangon Village, specifically in the year 2022. The spatial distribution of dengue fever cases in the 2020-2022 period within the Sememi Health Center's service area in Surabaya can be observed in the Fig. 2.

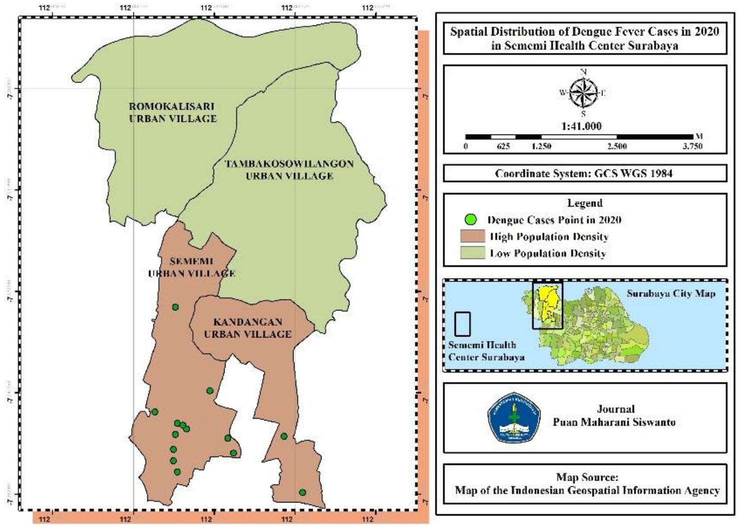


Fig. 2. Spatial Distribution of Dengue Cases in 2020 in Sememi Health Center Surabaya

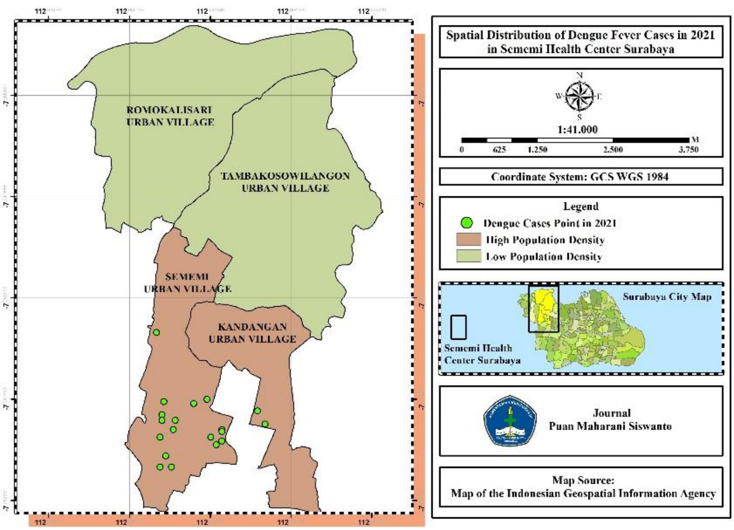


Fig. 3. Spatial Distribution of Dengue Cases in 2021 in Sememi Health Center Surabaya

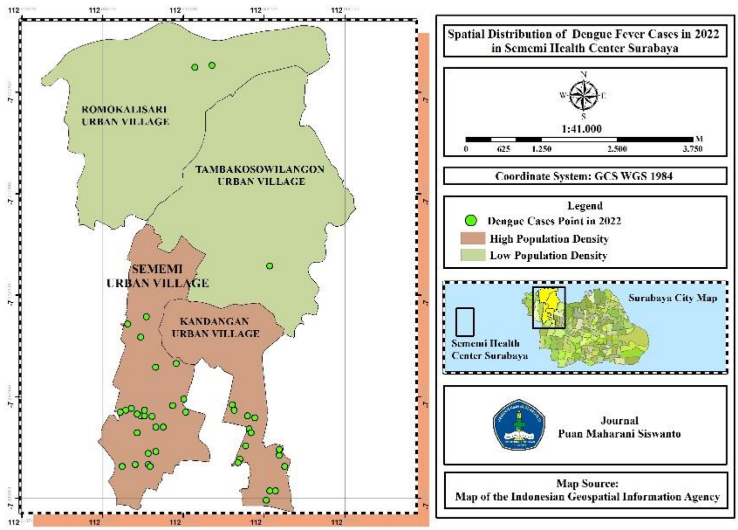


Fig. 4. Spatial Distribution of Dengue Cases in 2022 in Sememi Health Center Surabaya

Based on the dengue fever cases distribution in Fig. 2, Fig. 3. Fig. 4, it is evident that the number of DHF cases in Sememi Health Center Surabaya has continued to rise from 2020 to 2022. It is plausible that the number of DHF cases will further increase in the coming years. The surge in DHF cases can be attributed to a single factor, which is population mobility. Individuals who work or travel outside the area may facilitate the quicker transmission of the virus from one locality to another[9]. Additionally, the DHF virus transmission will spread more rapidly in areas with high population density[11].

The higher the population density, the greater the number of breeding sites or containers for the mosquitoes that transmit dengue fever [32].

The result of research by Risva et al. indicates a spatial relationship between population density and the incidence of dengue fever. Specifically, they found that as the population density increases, the number of dengue fever cases also increases[23]. This research aligns with a study conducted by Amelinda et al., which similarly establishes a correlation between population density and the transmission of dengue cases[2].

This research has not examined host factor variables that influence dengue cases, such as population mobility, population gender, and age of sufferers. Future researchers conducting similar studies may consider including these variables to enhance the result of mapping analysis using Geographic Information Systems (GIS). This is because the increase in the spread of dengue fever is not solely attributed to the presence of the vector but also influended by other factors, namely host factors [16].

3.3 Spatial Distribution of FLI from 2020-2022 in Sememi health Center Surabaya

Data on FLI for 2020-2022 in Sememi Health center can be seen in Fig. 5.

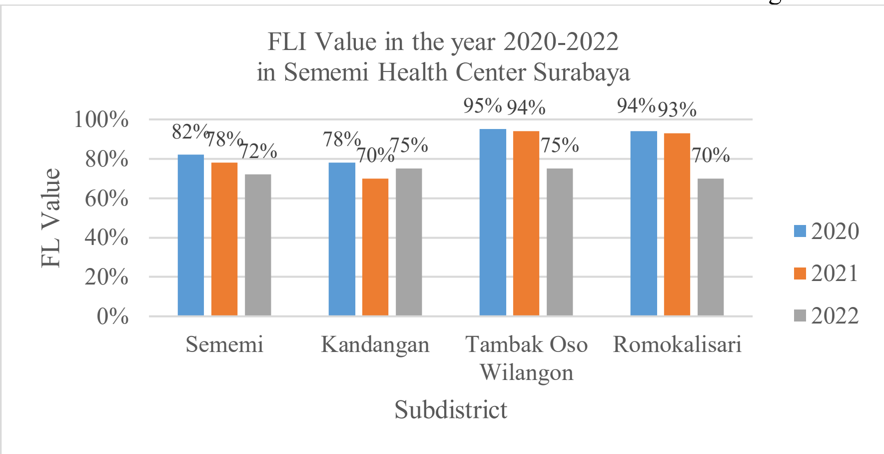


Fig. 5. FLI in the Year 2020-2022 in the Sememi Health Center Surabaya

The FLI value varies each year in every sub-district. The highest FLI scores are found in Tambak Oso Wilangon and Romokalisari sub-districts, while the lowest FLI values are observed in Sememi and Kandangan sub-districts. The spatial distribution of FLI from 2020-2022 can be seen in the Fig. 6.

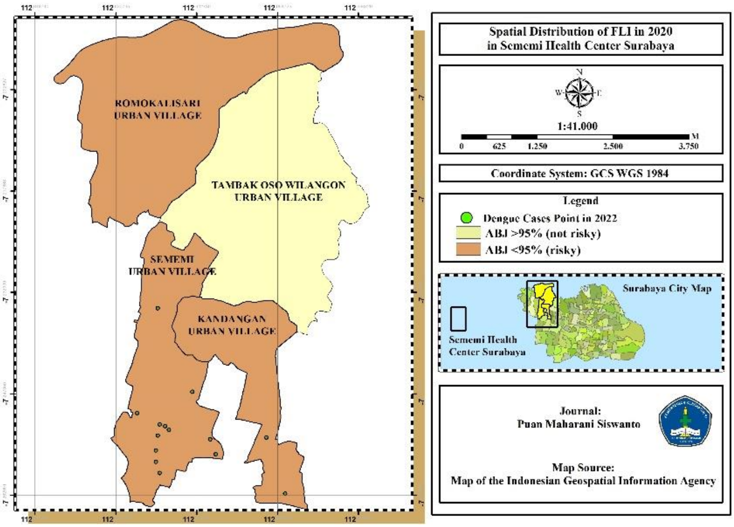


Fig. 6. Spatial Distribution of FLI in 2020 in Sememi Health Center Surabaya

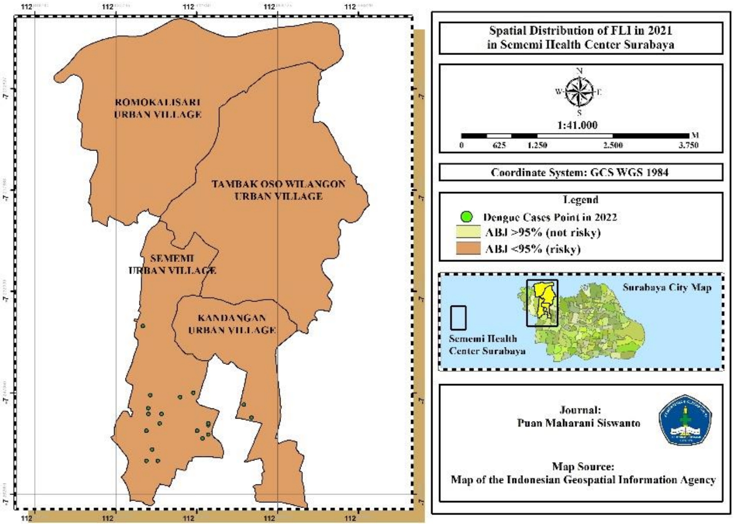


Fig. 7. Spatial Distribution of FLI in 2021 in Sememi Health Center Surabaya

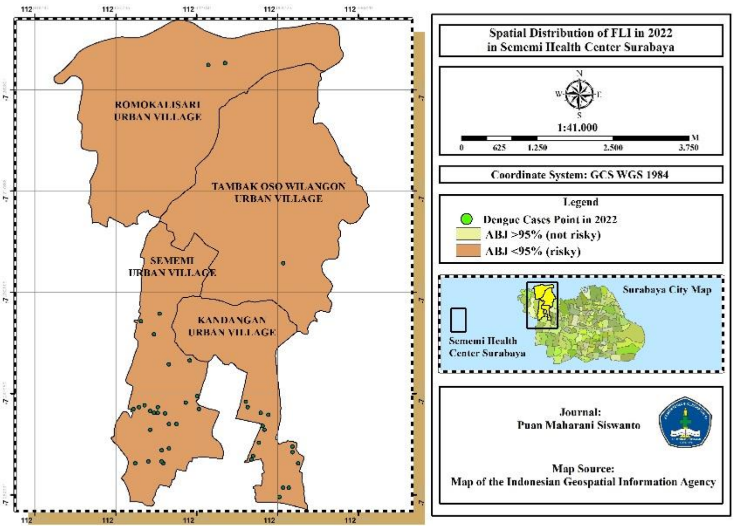


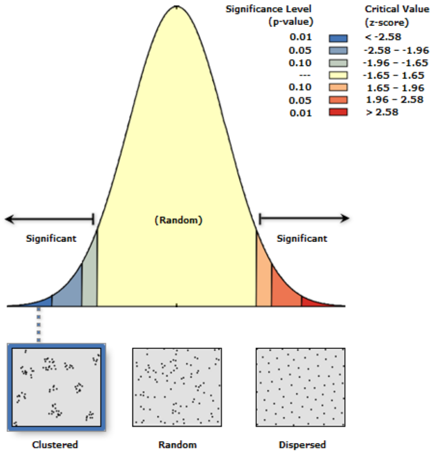
Fig. 8. Spatial Distribution of FLI in 2020 in Sememi Health Center Surabaya

The spatial distribution of FLI from 2020 to 2022 within the Sememi City Health Surabaya is presented in Fig. 6, Fig. 7 and Fig.8. It is categorized into two groups: the 'risk' category with an FLI value below 95% and the 'non-risk' category with an FLI value of 95% or higher. The risk category is represented on a map with dark colors, while the non-risk category is depicted on a map with light colors. Based on the spatial distribution results, it is evident that FLI values in the working area of the Sememi Health Center in Surabaya City have consistently decreased year by year.

The government has undertaken various efforts to combat the dengue problem. These efforts include sustainable eradication 0f 3M Plus mosquito breeding sites, surveillance of both dengue cases and vectors[7, 18]. All of these control efforts have been regularly implemented by the Sememi Health Center Surabaya. however, there are still obstacles leading to an increase in dengue cases and a higher risk for FLI. One of these obstacles is the lack of awareness among many people that the larvae creatures found in water containers are actually mosquito larvae. These challenges can be mitigated through health promotion activities aimed at enhancing public understanding of the mosquito life cycle, ultimately increasing public knowledge[15, 28].

3.4 Spatial Analysis using Average Nearest Neighbor (ANN)

The spatial distribution pattern of dengue cases can be determined using Average Nearest Neighbor (ANN) analysis. The results of the ANN analysis of dengue cases in 2020-2022 in the Sememi Health Center Surabaya can be observed in Figure 9.



Average Nearest Neighbor Summary

Observed Mean Distance:	134,7003 Meters
Expected Mean Distance:	252,1977 Meters
Nearest Neighbor Ratio:	0,534106
z-score:	-7,718779
p-value	0,00000

Fig. 9. Result of Average Nearest Neighbor (ANN) Analysis

Fig. 9 shows the results of ANN spatial analysis. Based on the outome from the analysis above, result was obtained with a z-score value of -7.718. The z-score value of -7.718, which was less than -2.58, indicated the presence of a spatial pattern of DHF cases in the Sememi Health Center Surabaya during 2020-2022.

The ANN analysis results revealed a Nearest Neighbor Index (NNI) value of 0.53, which was less than 1. This suggested that the spread pattern of DHF during 2020-2022 in Sememi Health Center Surabaya was clustered. This clustered pattern signified that dengue cases were relatively close to each other geographically [20]. It's important to note that areas with clustered patterns and close geographical distances may have experienced an increased risk of dengue outbreaks[8, 12].

Geographic Information Systems (GIS), a spatial technology, played a crucial role in data processing and planning within the health sector [31]. The advancement of GIS technology had yielded highly effective analytical tools for combating infectious diseases like DHF[23]. Spatial analysis of the dengue fever spread could be visualized through digital graphics and presented as maps using GIS tools[25]. Furthermore, spatial analysis could identify distribution patterns, which could aid in addressing dengue cases within a particular area[14, 24].

3.5 Spatial Analysis using Bivariate Local Moran's I

The results of the Bivariate Local Moran's I analysis include Moran's Scatterplot and the Local Indicator of Spatial Autocorrelation (LISA). Figure 10 representing the relationship between DHF cases and FLI in 2020-2022 in Sememi Health Center Surabaya.

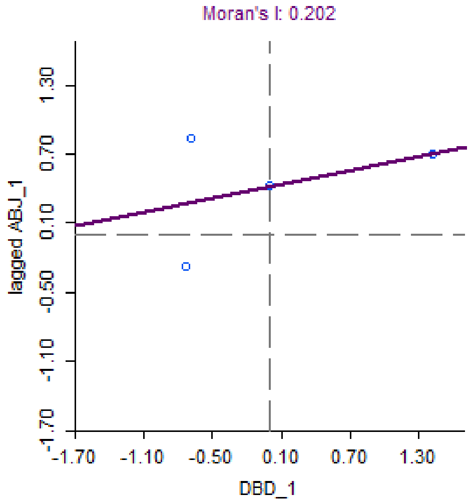


Fig. 10. Moran's Scatterplot

Fig. 10 displays the result of Moran's Ianalysis between DHF cases and FLI yielded I=0.202, indicating positive spatial autocorrelation. Positive spatial autocorrelation signifies a correlation between DHF cases and FLI. The results of Moran's I analysis are also presented in four quadrants[30]. Quadrant I, located in the top right, is High-High (HH), indicating that sub-districts with high dengue cases are surrounded by FLI values that are at risk. Quadrant II, situated in the top left, is Low-High (LH), signifying that sub-districts with low dengue cases are surrounded by risky FLI values. Quadrant III, found in the bottom left, is Low-Low (LL), representing sub-districts with low dengue cases surrounded by FLI values that are not at risk. Lastly, Quadrant IV, located in the bottom right, is High-Low (HL), indicating sub-districts with high cases of dengue fever surrounded by FLI values that are not at risk.

After determining the Moran's I value, A Local Indicator of Spatial Autocorrelation (LISA) analysis is conducted to asses local spatial relationship between regions[25]. Based on the results of the LISA analysi, it is evident that three sub-districts exhibit significant spatial autocorrelation: Kandangan village, Tambak Oso Wilangon village, and Romokalisari village. The High-High (HH) and Low-Low (LL) quadrants indicate positive spatial autocorrelation between regions, while High-Low (HL) and Low-High (LH) quadrants indicate negative spatial autocorrelation between regions(fig. 11)[3].

Positive spatial autocorrelation indicates that adjacent locations have similar values and have patterns that tend to be clustered, while negative spatial autocorrelation indicates that adjacent locations have different values and have patterns that tend to spread[10]. The limitation of this research is that the FLI data used are not based on surveys but rely on secondary data. It is recommended that future researchers employ survey methods to enhance the depth and quality of the analysis results.

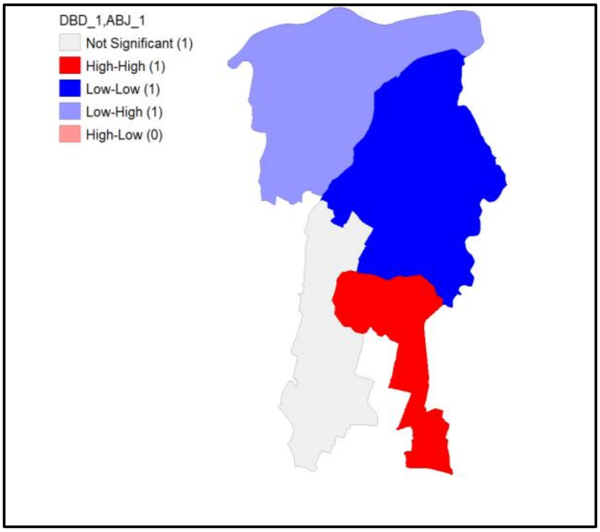


Fig. 11. Local Indicator of Spatial Autocorrelation

4 Conclusion

The number of DHF cases from 2020 to 2022 within the operational area of Sememi Health Center Surabaya totaled 76, distributed across four sub-districts. The highest number of cases was reported in the Sememei sub-district. The FLI in the Sememi Health Center Surabaya still does not meet the 95% requirement, indicating the potential for the spread of dengue fever. The spatial distribution pattern of DHF cases in Sememi Health Center Surabaya was characterized as clustered. The results of Bivarite Moran's I indicate a correlation between FLI and dengue fever cases.

To interrupt the dengue fever transmission chain, it was essential to engage the community through routine larva eradication activities. This could be accomplished by reducing potential breeding sites for mosquito larvae through regular cleaning of water reservoirs, securely sealing water containers, and maintaining the cleanliness of objects that could collect water and serve as mosquito breeding sites.

References

1. Alwi Paluseri, A.M. et al.: Analysis of the Influence of Environmental Health Interventions Based on The Health Belief Model (HBM) on the Risk Factors of Dengue Hemorrhagic Fever (DHF) Benteng Village, Indonesia. Natl. J. Community Med. 14, 9, 568–574 (2023). https://doi.org/10.55489/njcm.140920233220.

2. Amelinda, Y.S. et al.: The effects of climate factors, population density, and vector density on the incidence of dengue hemorrhagic fever in South Jakarta Administrative City 2016-2020: an ecological study. Acta Biomed. 93, 6, (2022). https://doi.org/10.23750/abm.v93i6.13503.
3. Astuti, S.D. et al.: Analisis Autokorelasi Spasial Kejadian Demam Berdarah Dengue (DBD) di Kabupaten Klaten Tahun 2020. J. Vektor Penyakit. 16, 1, 23–32 (2022). https://doi.org/10.22435/vektorp.v16i1.5817.
4. Badan Pusat Statistik Provinsi Jawa Timur: Provinsi Jawa Timur Dalam Angka 2022. (2022).
5. Dinas Kesehatan Kota Surabaya: Profil Kesehatan Surabaya Tahun 2020. 3, April, 49–58 (2020).
6. Dja'afar, T. et al.: Knowledge, Attitudes, and Behavior of Larva Monitoring Interpreter (Jumantik) Cadre as Efforts to Prevent Dengue Cases. Open Access Maced. J. Med. Sci. 10, 278–282 (2022). https://doi.org/10.3889/oamjms.2022.8453.
7. Gani, H. et al.: Dengue hemorrhagic fever incidence in Indonesia using trend analysis test and spatial visualization. Int. J. Public Heal. Sci. 11, 4, 1190–1201 (2022). https://doi.org/10.11591/ijphs.v11i4.21533.
8. Hajrah, U. et al.: Spatial pattern analysis on incidence of dengue hemorrhagic fever (DHF) in the Leuwigajah, West Java, Indonesia. Spat. Inf. Res. 31, 3, 359–367 (2023). https://doi.org/10.1007/s41324-022-00501-1.
9. Indriani, C. et al.: Baseline characterization of dengue epidemiology in Yogyakarta City, Indonesia, before a randomized controlled trial of wolbachia for arboviral disease control. Am. J. Trop. Med. Hyg. 99, 5, 1299–1307 (2018). https://doi.org/10.4269/ajtmh.18-0315.
10. Ispriyanti, D. et al.: Modelling space of spread Dengue Hemorrhagic Fever (DHF) in Central Java use spatial durbin model. J. Phys. Conf. Ser. 1025, 1, (2018). https://doi.org/10.1088/1742-6596/1025/1/012112.
11. Istiqamah, S.N.A. et al.: Correlation study between elevation, population density, and dengue hemorrhagic fever in Kendari city in 2014–2018. Open Access Maced. J. Med. Sci. 8, T2, 63–66 (2020). https://doi.org/10.3889/oamjms.2020.5187.
12. Larasati, N., Yudhastuti, R.: DBD Event Mapping, Strong Relation Of Climate Conditions And Population Mobility Number With Dbd Incidence. Indones. J. Public Heal. 15, 1 SE-Articles, 37–48 (2020). https://doi.org/10.20473/ijph.v15i1.2020.37-48.
13. Maharsi, S. et al.: Efectivity Evaluation among Dengue Control Programs in Semarang City, Indonesia. Unnes J. Public Heal. 9, 2, 135–140 (2020). https://doi.org/10.15294/ujph.v9i2.37512.
14. Maretha, L. et al.: The Relation between Rainfall and Larval Density of Dengue Hemorrhagic Fever with Spatial Modeling. Media Kesehat. Masy. Indones. 18, 1, 10–17 (2022). https://doi.org/10.30597/mkmi.v18i1.18388.
15. Mars Wijayanti, S.P. et al.: Mosquito Indices in Outdoor Spatial Spraying Treated Area, Banyumas Regency, Indonesia. IOP Conf. Ser. Earth Environ. Sci. 255, 1, (2019). https://doi.org/10.1088/1755-1315/255/1/012033.
16. Martini, M. et al.: Larvae Density and Environmental Condition as Risk Factors to Dengue Incidence in Semarang City, Indonesia. IOP Conf. Ser. Earth Environ. Sci. 380, 1, (2019). https://doi.org/10.1088/1755-1315/380/1/012010.
17. Massaid, A.B. et al.: Pemetaan Persebaran Kasus Demam Berdarah Dengue Di Desa

Wedarijaksa, Kecamatan Wedarijaksa, Kabupaten Pati. J. Kesehat. Masy. 9, 5, 609–612 (2021). https://doi.org/10.14710/jkm.v9i5.31100.
18. Minarti, M. et al.: Community knowledge and attitudes about the transmission of dengue haemorrhagic fever and its relationship to prevention behaviour in palembang, south sumatra, Indonesia. Open Access Maced. J. Med. Sci. 9, 1534–1543 (2021). https://doi.org/10.3889/oamjms.2021.7693.
19. Nuranisa, R. et al.: Correlation Of Free Larvae Index And Population Density With Dengue Fever Incidence Rate. Indones. J. Public Heal. 17, 3 SE-Articles, 477–487 (2022). https://doi.org/10.20473/ijph.v17i3.2022.477-487.
20. Nurhidayati, A. et al.: Analisis Spasial Autokorelasi Kejadian Demam Berdarah Dengue (DBD) di Kota Tangerang Selatan Tahun 2014-2019. J. Ilmu Kesehat. Masy. 11, 01, 68–74 (2022). https://doi.org/10.33221/jikm.v11i01.962.
21. Nurmayanti, D. et al.: Geographic Distribution of DHF Cases and Larvae Free Index In Situbondo Regency, 2019-2021. Media Kesehat. Masyrakat Indones. 19, 1, 9–18 (2023). https://doi.org/https://doi.org/10.30597/mkmi.v19i1.22633.
22. Rejeki, D.S.S. et al.: A spatiotemporal analysis of dengue hemorrhagic fever in Banyumas, Indonesia. Int. J. Public Heal. Sci. 10, 2, 231–240 (2021). https://doi.org/10.11591/ijphs.v10i2.20713.
23. Risva et al.: Spatial Distribution of Dengue Haemorrhagic Fever (DHF) Vulnerability Level Based on Population Density, Rainfall, Drainage Condition, Natural Water Body, and Vector Control Program in Tanjung Redeb Sub-District, District of Berau, East Kalimantan. IOP Conf. Ser. Earth Environ. Sci. 187, 1, (2018). https://doi.org/10.1088/1755-1315/187/1/012063.
24. Riyanto, I.A. et al.: The spatiotemporal analysis of dengue fever in Purwosari district, Gunungkidul Regency, Indonesia. Indones. J. Geogr. 52, 1, 80–91 (2020). https://doi.org/10.22146/ijg.49366.
25. Rosvita, N.A. et al.: Spatial-temporal distribution of dengue in Banjarmasin, Indonesia from 2016 to 2020. Int. J. Public Heal. Sci. 11, 4, 1167–1175 (2022). https://doi.org/10.11591/ijphs.v11i4.21780.
26. Satoto, T.B.T. et al.: Entomological index and home environment contribution todengue hemorrhagic fever in Mataram City, Indonesia. Kesmas. 15, 1, 32–39 (2020). https://doi.org/10.21109/kesmas.v15i1.3294.
27. Sugardo, B.N. et al.: Climate variability (temperature, humidity, rain intensity and wind speed) and dengue hemorrhagic fever case correlations in Depok City in 2009-2018. IOP Conf. Ser. Earth Environ. Sci. 737, 1, (2021). https://doi.org/10.1088/1755-1315/737/1/012001.
28. Sukesi, T.W. et al.: Effects of health education based intervention on community's perception, healthy house, and social capital of dengue in endemic area of sleman regency indonesia. Open Access Maced. J. Med. Sci. 9, 428–436 (2021). https://doi.org/10.3889/oamjms.2021.6087.
29. Sukesi, T.W., Astuti, C.T.: Hubungan Angka Bebas Jentik (Abj) Dengan Insidence Rate Demam Berdarah Dengue (Dbd) Di Tingkat Kabupaten Sleman Tahun 2013-2017. J. Kesehat. dan Pengelolaan Lingkung. 1, 2, 57–63 (2020). https://doi.org/10.12928/jkpl.v1i2.4159.
30. Suryowati, K. et al.: A Comparison of Weights Matrices on Computation of Dengue

Spatial Autocorrelation. IOP Conf. Ser. Mater. Sci. Eng. 335, 1, (2018). https://doi.org/10.1088/1757-899X/335/1/012052.
31. Tessema, Z.T. et al.: A Systematic Review of Areal Units and Adjacency Used in Bayesian Spatial and Spatio-Temporal Conditional Autoregressive Models in Health Research. Int. J. Environ. Res. Public Health. 20, 13, (2023). https://doi.org/10.3390/ijerph20136277.
32. Washliyah, S. et al.: Hubungan Tempat Perindukan dengan Kepadatan Larva Aedes aegypti sebagai Vektor Penyakit Demam Berdarah Dengue di Wilayah Kerja Puskesmas Kalumata Kota Ternate (Relationship of the Breeding Place with the Density of Aedes aegypti Larva as a Dengue Haemorha. J. Bios Logos. 9, 2, 62 (2019). https://doi.org/10.35799/jbl.9.2.2019.24174.