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Spatial Analysis for the Identification of Priority Areas Dengue in West Sumatera Province, Indonesia

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Abstract:
Dengue is transmitted by mosquitoes in the genus Aedes, particularly Aedes aegypti and Aedes albopictus. West Sumatra Province is a tropical area in Indonesia where the two main mosquito genera are endemic in almost all regions year-round. This study analysed distribution of dengue, and defined the priority dengue areas in West Sumatra in 2017 using spatial autocorrelation (Moran's I) and Moran's scatter plot. The result revealed the global Moran's index of the case patterns to be a cluster or positive correlation ($I > 0$, $p < 0.01$), and Moran scatter plot indicated associations between districts and their neighbours. Dengue cases in each district were described as high-high (HH), high-low (HL, hotspot), low-high (LH, cold spot), or low-low (LL). Districts identified as HH should be prioritized, and dengue must be controlled in HL and LH districts. In LL districts, dengue programs should be maintained. The results of this study could help implement strategies to prevent and control dengue.

Keywords: *Dengue, spatial autocorrelation, Indonesia*

1. Introduction

About 2.5 billion people live under the threat of dengue fever, more than 75%, or about 1.8 billion, sufferers live in the Asia Pacific region. About two-fifths of the world's population in tropical and subtropical countries are at risk of dengue fever and dengue. The area effected by dengue has increased recently, especially in Thailand, Myanmar, and Indonesia (WHO, 2011). In Indonesia, the number of districts affected by dengue has 434 (84.44%) in 2017 and 440 (85.60%) in 2018 (Kementerian Kesehatan RI, 2019). Indonesia reported the highest number of cases, according to the World Health Organization (WHO), for the Southeast Asia region (WHO, 2012).

The targets for health development in the Strategic Plan of the Ministry of Health of Indonesia in 2015–2019 include reducing the morbidity rates due to infectious diseases in districts to less than 49 per 100,000 population (Kementerian Kesehatan RI, 2017a). Unfortunately, dengue fever is still a public health problem in Indonesia. This includes West Sumatra, which has morbidity rates > 49 per 100,000 population. The incidence of dengue per 100,000 population in West Sumatra was 45.66 in 2014, 73.24 in 2015, and 75.75 in 2016 (Kementerian Kesehatan RI, 2018, 2017b, 2016).

Spatial analysis can be used to determine when and where cases of specific diseases occurred and could resurface in the future, and it can be used to study the spatial patterns of disease incidence in a particular area (Bivand et al., 2013; Waller and Gotway, 2004; Williams and Elliott, 2015). Spatial autocorrelation statistics are typically global descriptors of data that measure the degree of similarity between the target region and its neighbouring geographic areas (the spatial relationships between regions). Spatial autocorrelation can be measured using the global Moran's index. The global Moran's index is used to measure global spatial autocorrelation (Fitzmaurice, 2016; Plant, 2019; Zhang et al., 2014).

In this study, we assessed and mapped the dengue incidence rate for 169 sub-districts in West Sumatra to define the priority areas.

2. Method

This research was conducted in 169 sub districts in 2017 in West Sumatra Province, Indonesia. West Sumatra Province is located between 0°54' north latitude and 3°30' south latitude, and between 98°36' and 101°53' east longitude. West Sumatra lies in the middle of the western coast of Sumatra and occupies an area of 42.2 thousand km^2 (BPS Provinsi Sumatera Barat, 2018). Data used in this study were collected from the West Sumatra Provincial Health Office.

We used the global Moran's index and Local Indicators of Spatial Association (LISA) to analyse distribution and define the dengue priority areas. The global Moran's index values vary from −1.0, indicating an inverse correlation (dispersed), to 1.0, indicating a direct correlation (clustered). Values of zero and close to zero indicate a random distribution (Lloyd, 2011). The three categories of spatial autocorrelation were positive, negative, and null. Positive spatial correlation, or clustering, occurs when the nearby locations have a similar value. When nearby locations have dissimilar values, Moran's *I* is negative, and this is called negative spatial autocorrelation, which indicates that cases are dispersed.

Null spatial autocorrelation indicates that the spatial pattern is random. Increasingly positive values of Moran's *I* is associated with increasingly positive autocorrelation, whereas negative values are associated with negative autocorrelation (Fitzmaurice, 2016; Hafeez et al., 2017; Plant, 2019; Zhang et al., 2014).

Spatial clustering is the process of grouping a set of spatial objects into clusters so that objects within a cluster are highly similar to each other but are different from objects in other clusters. LISA statistics are defined for each cell of an area in the data set to serve as an indicator of the spatial clustering of similar values. The main purpose of this indicator is to provide a local measure of similarity between each region's associated value (Fotheringham and Rogerson, 2009; Plant, 2019). This study used LISA for the identification of local spatial clusters. LISA analysis indicates the presence or absence of associations with neighbours and outliers. LISA classifies areas as high-high (HH), low-high (LH), high-low (HL), or low-low (LL) (Lloyd, 2011).

3. Result and Discussion

3.1. Result

In 2017 found 55 sub-districts (32.54%) with incidence rate >49 per 100,000 population. Sub-district with IR>49 per 100,000 population is spread across 16 districts in West Sumatra Province. Figure 1 shows that the incidence rate (per 100,000 population) of dengue in West Sumatra in 2017.

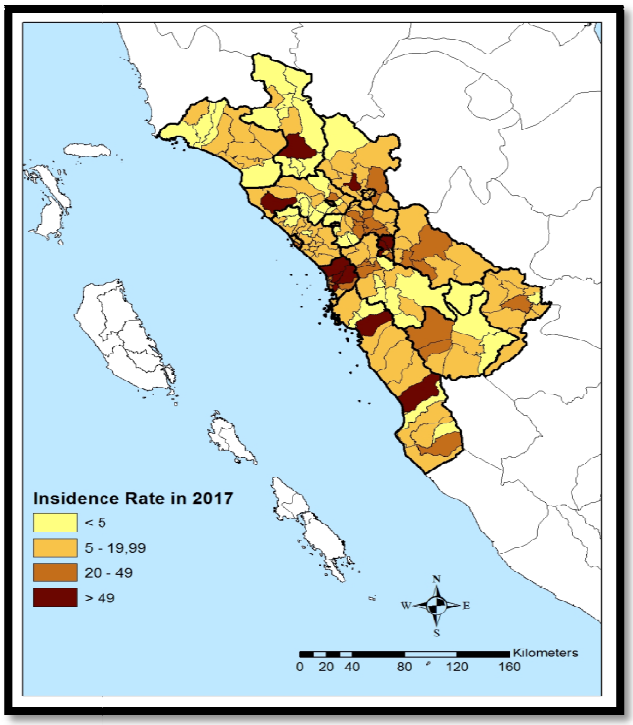

Figure 1: Spread of Incidence Rate of Dengue per 100,000 Populations in West Sumatra Province

The global Moran's I statistic was used to assess the presence and strength of spatial autocorrelation across the study area and to test the assumption of spatial independence in the implementation of spatial pattern analysis. The global Moran's I value (0,1933) was greater than zero ($p<0.05$), the analysis shows that the dengue cases in West Sumatra are clustered, which means they are always related to each other. The global Moran's I statistic indicates the mean of the local spatial Moran's I. The research shows the locations with the high-high (HH) correlation indicating a high category in the cluster map, low-low (LL) indicating a low category in the cluster map. High-low (HL) and low-high (LH) are area with negative local spatial autocorrelation. In the HH districts, the incidence rate of dengue in the district and the surrounding districts is high. In the HL districts, the incidence rate of dengue is high while the cases in the surrounding districts are low. In the LH districts, the incidence rate of dangue in the district are low while the cases in the surrounding districts are high, indicating a cold spot. Finally, in the LL districts, the incidence rate of dengue in the district and in the surrounding districts are low.

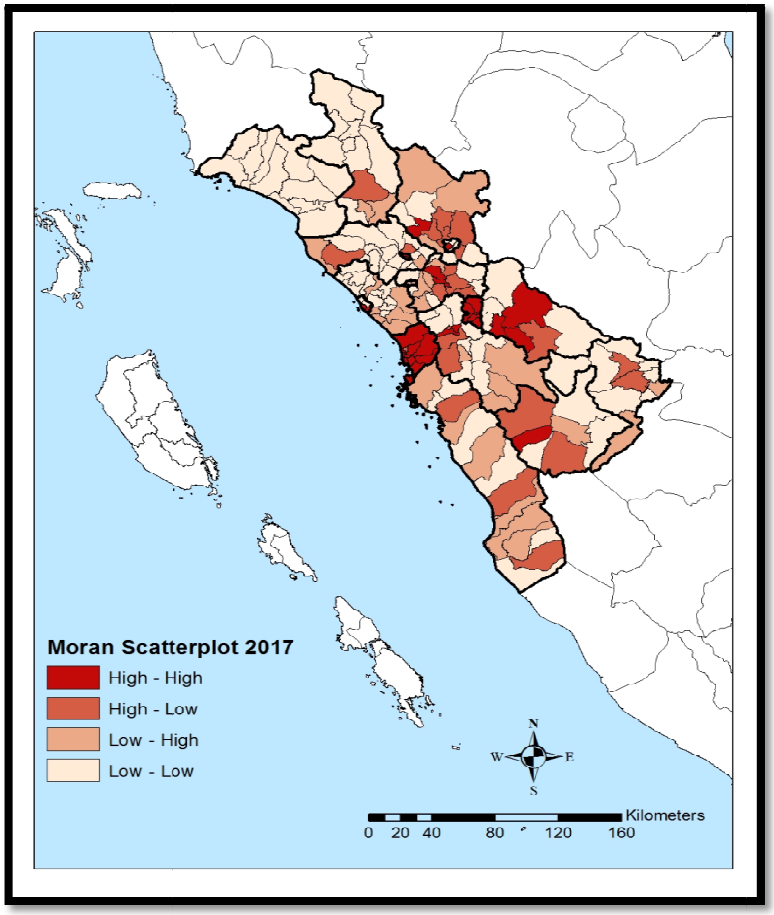

Figure 2: Local Indicators of Spatial Association (LISA) Dengue in West Sumatra, Indonesia

3.2. Discussion

In this study, we used Moran's *I* to measure the relationship between the values based on the location and the variation in dengue attributes in the locations. The Moran's *I* analysis indicated whether the dengue cases were clustered. In this research, the global Moran's *I* was greater than zero ($p<0.05$), and the dengue cases in neighbouring districts showed spatial autocorrelation. The adjacent districts had similar high or low rates in comparison with those located farther away. This indicates the significant positive spatial autocorrelation of dengue cases across the study area.

In other studies, the global Moran's index value ranged from 0.148 to 0.743 in Bali ($p < 0.05$); 0.28 in Timor-Leste ($p < 0.0001$); 0.475 in Mainland China ($p = 0.01$); 0.59 in Guangzhou, China ($p < 0.01$); 0.36 in Queensland, Australia ($p < 0.003$); and 0.336 ($p < 0.001$) in 2008–2009 and 0.036 in 2012–2013 ($p = 0.416$) in New Caledonia, Australia. The spatial autocorrelation (global Moran's *I*) results showed that the dengue fever cases in the study area were clustered (Chen et al., 2019; Dhewantara et al., 2019; Naish and Tong, 2014; Yue et al., 2019, 2018; Zellweger et al., 2017) included in Cimahi, Indonesia (Dhewantara et al., 2015).

In this research, a significance map was used to identify the locations with significant local Moran's *I* statistics using different colours and as a local indicator of the spatial association. There are 28 sub-districts with cases of dengue both in the sub-district and the surrounding sub-districts were high in two districts. This demonstrates the need to prioritise and control the number of people being infected with dengue in these districts.

There are 27 sub-districts in particular exhibited an HL correlation. This means this sub districts are potentially a source of dengue disease; thus, it is especially important to control the spread of dengue in this district. Districts that are surrounded by hotspots will be particularly threatened by a dengue disease outbreak.

The number of districts classified as LH are 34 districts. These districts have the potential to be effective by the spread and increase in dengue disease that is transmitted by the surrounding high-prevalence areas. The district and surrounding areas that are assigned LL are lower priority. In managing public health, dengue mapping with LISA provides important information for addressing the control and spread of dengue cases.

4. Conclusion

In this study, we identified the high-priority districts and associated factors of the spread of dengue in West Sumatra, Indonesia, which can be used to enhance surveillance systems and control measures. The district categorised as HH should be prioritised to reduce the incidence rate and the spread of dengue should be controlled in HL districts. Prevention measures should be introduced in districts that are prone to the spread of dengue (LH). In LL districts, the current dengue program should be maintained. These findings provide important information for public health authorities to prioritise and target dengue control, create further strategic planning for better prevention and control measures, and enhance and implement elimination interventions in West Sumatra.

5. Author Contributions

Efriza Efriza **;** Conceptualization, Data curation, Formal analysis, Methodology, Validation, Visualization, Writing-original draft, Writing-review and editing. Tris Eryando**;** Conceptualization, Methodology, Supervision, Validation, and Writing-review and editing.

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7. References

i. Bivand, R.S., Pebesma, E., Gomez-Rubio, V., 2013. Applied Spatial Data Analysis with R, Second Ed. ed. Springer, New York. https://doi.org/10.1007/978-1-4614-7618-4
ii. BPS Provinsi Sumatera Barat, 2018. Provinsi Sumatera Barat Dalam Angka. BPS Provinsi Sumatera Barat, Sumatera Barat.
iii. Chen, Y., Zhao, Z., Li, Zhichao, Li, W., Li, Zhipeng, Guo, R., Yuan, Z., 2019. Spatiotemporal Transmission Patterns and Determinants of Dengue Fever: A Case Study of Guangzhou, China. Int. J. Environ. Res. Public Health 16, 2486. https://doi.org/10.3390/ijerph16142486
iv. Dhewantara, P.W., Marina, R., Puspita, T., Ariati, Y., Purwanto, E., Hananto, M., Hu, W., Soares Magalhaes, R.J., 2019. Spatial and temporal variation of dengue incidence in the island of Bali, Indonesia: An ecological study. Travel Med. Infect. Dis. https://doi.org/10.1016/j.tmaid.2019.06.008
v. Dhewantara, P.W., Ruliansyah, A., Fuadiyah, M.E.A., Astuti, E.P., Widawati, M., Widawati, M., 2015. Space-time scan statistics of 2007-2013 dengue incidence in Cimahi city, Indonesia. Geospat. Health 10, 255–260. https://doi.org/10.4081/gh.2015.373
vi. Fitzmaurice, G., 2016. Handbooks of Modern Statistical Methods, Handbook of Spatial Epidemiology. CRC Press, New York.
vii. Fotheringham, A.S., Rogerson, P.A., 2009. Spatial Analysis. SAGE, London.
viii. Hafeez, S., Amin, M., Munir, B.A., 2017. Spatial mapping of temporal risk to improve prevention measures: A case study of dengue epidemic in Lahore. Spat. Spatiotemporal. Epidemiol. 21, 77–85. https://doi.org/10.1016/j.sste.2017.04.001
ix. Kementerian Kesehatan RI, 2019. Profil Kesehatan Indonesia Tahun 2018. Kementerian Kesehatan RI, Jakarta.
x. Kementerian Kesehatan RI, 2018. Profil Kesehatan Indonesia Tahun 2017. Kementerian Kesehatan RI, Jakarta.
xi. Kementerian Kesehatan RI, 2017a. Pedoman Pencegahan dan Pengendalian Demam Berdarah Dengue di Indonesia. Kementerian Kesehatan RI, Jakarta.
xii. Kementerian Kesehatan RI, 2017b. Profil Kesehatan Indonesia Tahun 2016. Kementerian Kesehatan RI, Jakarta.
xiii. Kementerian Kesehatan RI, 2016. Profil Kesehatan Indonesia Tahun 2015. Kementerian Kesehatan RI, Jakarta.
xiv. Lloyd, C.D., 2011. Local Models for Spatial Analysis, 2nd ed. ed. CRC Press, New York.
xv. Naish, S., Tong, S., 2014. Hot spot detection and spatio-temporal dynamics of dengue in Queensland, Australia. Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci. - ISPRS Arch. XL–8, 197–204. https://doi.org/10.5194/isprsarchives-XL-8-197-2014
xvi. Plant, R.E., 2019. Spatial Data Analysis in Ecology and Agriculture Using R, Second Ed. ed. CRC Press, New York.
xvii. Waller, L.A., Gotway, C.A., 2004. Applied Spatial Statistics for Public Health Data. Wiley, New Jersey.
xviii. WHO, 2012. Global Strategy for Dengue Prevention and Control 2012-2020, WHO. WHO, Geneva.
xix. WHO, 2011. Comprehensive Guidelines for Prevention and Control of Dengue and Dengue Haemorrhagic Fever, Revised an. ed, WHO Regional Publication SEARO. WHO, India.
xx. Williams, A., Elliott, S., 2015. Spatial Analysis in Health Geography. Ashgate, England.
xxi. Yue, Y., Liu, X., Xu, M., Ren, D., Liu, Q., 2019. Epidemiological dynamics of dengue fever in mainland China, 2014–2018. Int. J. Infect. Dis. 86, 82–93. https://doi.org/10.1016/j.ijid.2019.06.015
xxii. Yue, Y., Sun, J., Liu, X., Ren, D., Liu, Q., Xiao, X., Lu, L., 2018. Spatial analysis of dengue fever and exploration of its environmental and socio-economic risk factors using ordinary least squares: A case study in five districts of Guangzhou City, China, 2014. Int. J. Infect. Dis. 75, 39–48. https://doi.org/10.1016/j.ijid.2018.07.023
xxiii. Zellweger, R.M., Cano, J., Mangeas, M., Taglioni, F., Mercier, A., Despinoy, M., Menkès, C.E., Dupont-Rouzeyrol, M., Nikolay, B., Teurlai, M., 2017. Socioeconomic and environmental determinants of dengue transmission in an urban setting: An ecological study in Nouméa, New Caledonia. PLoS Negl. Trop. Dis. 11, 1–18. https://doi.org/10.1371/journal.pntd.0005471
xxiv. Zhang, J., M.Atkinson, P., Goodchild, M.F., 2014. Scale in Spatial Information and Analysis. CRC Press, Florida.