EXPLORING SPATIO-TEMPORAL CLUSTER FOR DENGUE PREVENTION IN URBAN AREA OF INDONESIA

By SULISTYAWATI

WORD COUNT 3443
TIME SUBMITTED 05-DEC-2020 12:02AM
PAPER ID 66469461

IJPHCS
Open Access: e-Journal

International Journal of Public Health and Clinical Sciences
e-ISSN : 2289-7577.

EXPLORING SPATIO-TEMPORAL CLUSTER FOR DENGUE PREVENTION IN URBAN AREA OF INDONESIA

Sulistyawati Sulistyawati[1]*, Fardhiasih D.A.[1], Aditya L.R.[2]

[1]Faculty of Public Health, Ahmad Dahlan University, Yogyakarta, 55164, Indonesia.
[2]Center for Environmental Study, Gadjah Mada University, Yogyakarta, 55281, Indonesia

*Corresponding author: Sulistyawati. Public Health Faculty, Jl. Prof. Dr. Soepomo, Janturan, Umbulharjo, Yogyakarta. Email:sulistyawatisuyanto@gmail.com

https://doi.org/10.32827/ijphcs.6.1.176

ABSTRACT

Background: Dengue is designated as a major health problem in tropical countries. Accordingly, there has been a regular program run by the government to overcome the outbreak of the disease which unluckily is still a lack of control. Therefore, we inevitably need an alternative to guide the intervention strategies to eliminate or at least minimize the insurmountable health problem. This research is thus aimed at investigating the space-time cluster of dengue fever transmission in Yogyakarta City, Indonesia using spatial scan statistics (SaTScan).

Materials and Methods: Spacetime permutation scan statistic was used to generate the cluster of dengue fever transmission in Yogyakarta City, by January to July 2014. There were 285 reported cases during the study period, but only 208 were confirmed by epidemiological investigation. We employed Geographical Positioning System for recording the location of the cases.

Result: The Dengue fever transmission was clustered temporarily in several spots during the research period. Mergangsan was granted as it is the most likely cluster for DF with a p-value of 0.005 in July 2014, while the second cluster was proven in the other sub-districts. This finding is valuable for guiding the future research about the intervention priority of dengue fever control in Yogyakarta City. There was a significant cluster of dengue cases in Yogyakarta City which is particularly located in Mergangsan sub-district.

Conclusion: GIS technic is applicable for disease surveillance. Together with another health program, this approach is useful to solve the disease problem.

Keywords: Dengue Fever, Spatial-Analysis, Yogyakarta, Indonesia

1.0 Introduction

Dengue Fever (DF) is an infectious disease, primary vector is female *Aedes aegypti* and the second vector is *Aedes albopictus* (Lambrechts, Scott, & Gubler, 2010). Dengue turns out to be a primary health problem in tropical countries, mainly in urban and semi-urban areas (WHO, 2015), this is because of the proper climate condition for the mosquito's breeding. *Aedes* can easily breed in nearby of the house, such as buckets, 200-liter drums, plastics and glass containers, ground cement tanks, plant pots, tires (WHO, 2011), jerrycan, polythene sheet, plastic bowl, and dustbin (Getachew, Tekie, Gebre-michael, Balkew, & Mesfin, 2015).

World Health Organization (WHO) has develops a global guideline to reduce the number of DF cases by primarily reducing DF mortality and morbidity 50% and 25% respectively in 2020 and by estimating the possible outbreak of the disease in 2015 (WHO, 2012). In the other hands, there have been many programs developed to fight dengue fever transmission. Unfortunately, the transmission remain occurs worldwide.

Several investigations have been made to assess the geographic approach as a tool to evaluate the pattern of disease transmission (Musa et al., 2013; Photis, 2016; Rodriguez-Morales et al., 2016). Likewise, spatial scan statistic in disease control (Pollack et al., 2006; Zhang, Assunção, & Kulldorff, 2010), (Sulistyawati, Nirmalawati, & Mardenta, 2016) which was enabled to describe a disease during the period and allow them to assess the existence of cluster among the cases. Researchers can fruitfully apply this approach to find the disease cluster to support the government struggle against the transmission of the disease (Jeefoo, Tripathi, & Souris, 2011).

Dengue still becomes the public health problem in Yogyakarta City, Indonesia. This city is highly prevalent of dengue (Tana, Umniyati, Petzold, Kroeger, & Sommerfeld, 2012), (QomaruddinMunir & Winarko, 2015). Figure 1 illustrates the number of DF cases in Yogyakarta City which was fluctuating and reached the peak in 2010. The daily temperature average of Yogyakarta is 27.2°C, and the average humidity is 24.7%(Yogyakarta City Government, 2002). Climate directly influences the vector such as distribution and longevity, pathogens, host and the interactions (Roiz, Ruiz, Soriguer, & Figuerola, 2014) also the transmission cycle of DF (Promprou, Jaroensutasinee, & Jaroensutasinee, 2005). Accordingly, Yogyakarta becomes a suitable habitat for the mosquitos. Also, in line with the previous research revealed the association between climate variables such as temperature, humidity and rainfall and dengue transmission (Hii et al., 2009).

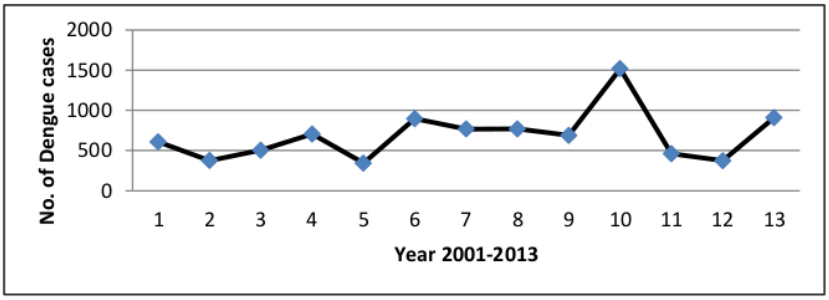

Figure 1. Dengue cases 2001-2013 in Yogyakarta City

Indonesia ministry of health incorporation with City Health Office of Yogyakarta has been conducting several routine dengue prevention programs which have been combined with a local program such as entomologist surveyor known as "jumantik" (Tana et al., 2012). This indicates that the local government has undertaken to control of Dengue transmission even though it remains to be undefeatable.

This research aim was to identify the local cluster of dengue in Yogyakarta City during Jan-July 2014.

2.0 Materials and Methods

Conducted in 2015 in Yogyakarta City, the research focuses on the analysis of DF cases based on the monthly report of the City Health Office during January-July 2014 particularly on laboratory-confirmed cases. There were 285 reported cases during this period, but only 208 were confirmed by epidemiological investigation (EI). This research focused on positive cases that followed up by EI. Geographical Positioning System (GPS) was employed for recording the location of the cases, while Spatial Scan Statistic (Satscan) software using the Kulldorf method of space-time permutation model was used to detect the cluster. Mapping of dengue case was done by using Arc GIS.

The current study was reviewed and approved by the institutional research review board of Ahmad Dahlan University, Indonesia.

3.0 Result

3.1 Dengue cases

Dengue Fever (DF) is one of death-defying and hard to combat diseases in big sprawling cities such as Yogyakarta, due to the escalating population density. Yogyakarta city is part of Yogyakarta Special Region retaining more than 200.000 people/m^2, thus making it as labelled as a highly populous city. During the research period, amount 208 dengue cases were involved in this analysis. Figure 2 shows that from the beginning of 2014 dengue cases was increased gradually and reduced slightly after the peak in May.

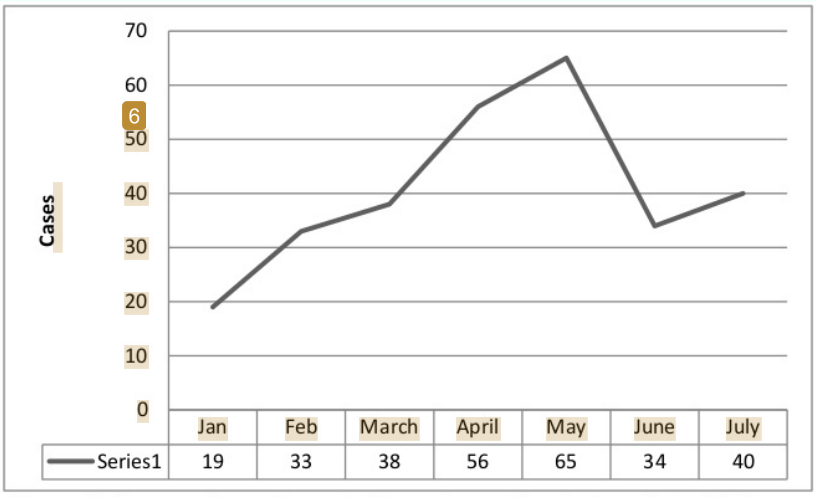

Figure 2. Dengue Fever Cases in Yogyakarta City, Indonesia in 2014

3.2 Dengue case distribution

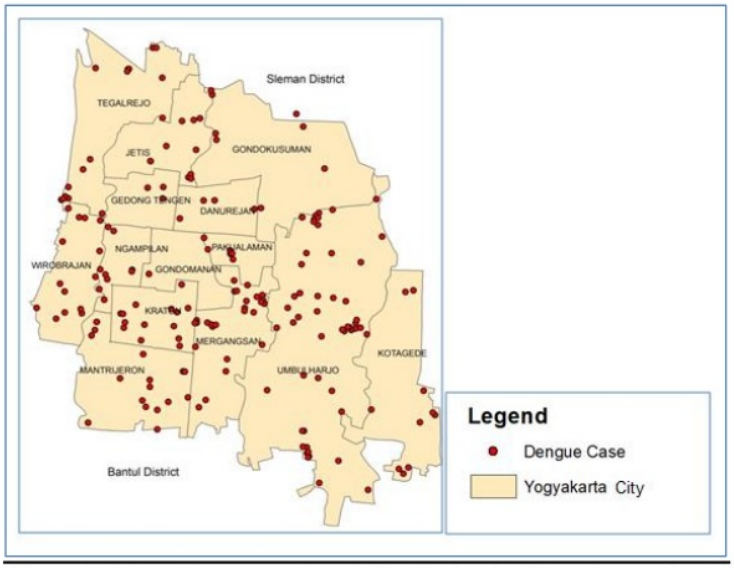

Figure 3. Map of Dengue Cases Distribution in Yogyakarta City, Indonesia (Jan-July 2014)

Figure 3 illustrates the distribution of dengue case during the study period in a spatial mode which tends to distribute in all sub-districts in Yogyakarta City eventually. In other words, the entire population in Yogyakarta city was threatened by Dengue Fever.

3.3 Dengue fever space-time analysis

Satscan was successful to recognised 7 clusters of Dengue cases during the period as presented in Table 1. Among which, one cluster (cluster 1) was the most likely cluster and statistically significant, the others were secondary clusters.

Table 1. Satscan using Space-Time Permutation Model

Cluster	Number of Cases	Radius (km)	Time Frame	P-value
1	**7**	**0.88**	**2014/7/1 to 2014/7/31**	**0.0050***
2	2	0.50	2014/6/1 to 2014/6/30	0.754
3	14	2.17	2014/5/1 to 2014/5/31	0.861
4	2	0.58	2014/6/1 to 2014/6/30	0.946
5	11	1.01	2014/1/1 to 2014/2/28	0.991
6	11	0.82	2014/1/1 to 2014/2/28	0.991
7	3	0.40	2014/4/1 to 2014/4/30	0.999

*significant at 0.05

4.0 Discussion

Some studies using Satscan analysis has successfully detected clusters of dengue case in Indonesia (Widyaningsih & Pin, 2008) such as in Samarinda, Indonesia (Boewono, Ristiyanto, Widiarti, & Widyastuti, 2012). Accordingly, our research focuses on a smaller area to enable an in-depth assessment of the cluster to propose prioritised intervention. Since the intervention in certain areas needs to be evidence-based, it is highly pivotal to build an appropriate intervention in the control of DF transmission.

This study revealed that various spatiotemporal distribution of DF in Yogyakarta City, while Dengue cases seem to be evenly distributed all over the areas. Spatial time cluster analysis is an incredibly helpful tool to assess how spatial patterns change over time (Banu et al., 2012). During the study period, discovered 7 clusters indicated to be the source of DF transmission in Yogyakarta City. Mergangsan Sub-District was the most likely cluster for DF transmission most probably owing to its high population density which was subsequently confirmed by a research stating that dengue fever transmission is associated with the population density (Banu et al., 2012). In line with this, Yogyakarta City said that Mergangsan population density is recorded to be 13.703 people/km^2. This sub-district is located in adjacent with the other endemic sub-districts such as Kraton and Mantrijeron which are also highly populous with 15.833 people/km^2 and 13.413 people/km^2 respectively. The crammed neighbourhood in big cities turns out to be the easy transmission of DF owing to a maximum flight range of *Aedes aegypt*y which is 200 meters (Suyasa, Putra, & Aryanta, 2007). Consequently, people live within a radius of 200 meters from the Dengue positive patient put at risk to dengue transmission.

Figure 4 shows that Wirobrajan, Tegalrejo, Danurejan, Gondomanan, and Kotagede were laid on the secondary clusters. Although the clusters were not primary, they could potentially harm the community surrounding. Yogyakarta is an educational and tourism city. This city becomes the destination for many people neither local, regional nor international with various purposes (Yogyakarta Province Tourism Agency, 2013)' (Yogyakarta Province Tourism Agency, 2015). Consequently, the mobility of the people in this region is pretty high which thus suspected to contribute to the dengue transmission in Yogyakarta greatly. This is confirming with previous research that dengue transmission is closely engaged with human mobility (Wesolowski et al., 2015). Likewise, social demographic of Yogyakarta which structured by the semi-resident and visitor may increase the risk to transmit dengue, as stated on Queensland's' dengue management plan that backpackers/hostels/guest houses, etc. as the potential high/medium risk (State of Queensland (Queensland Health), 2015).

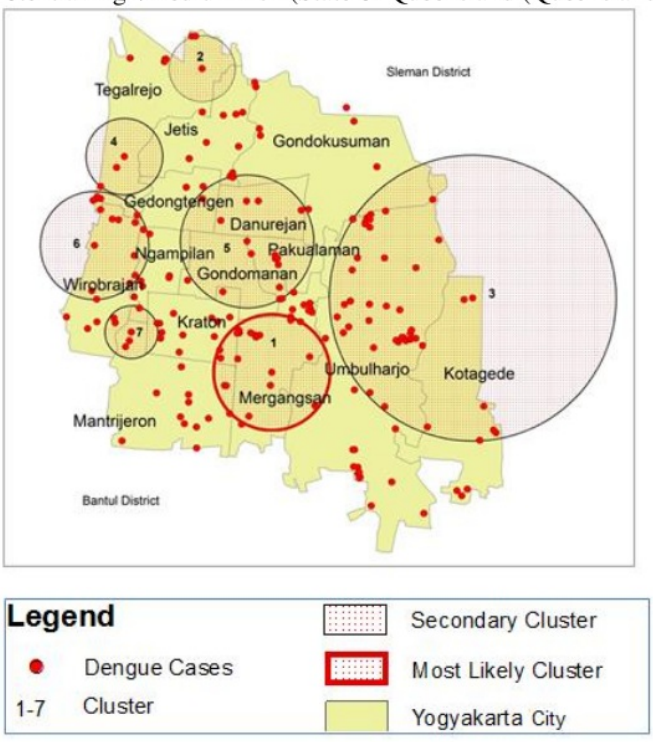

Figure 4. Map of Dengue Cluster (Jan-July 2014) in Yogyakarta City, Indonesia

The most likely cluster in Mergangsan sub-district Yogyakarta took time in July 2014 which was coincided with Muslim holidays during which people from another part of Indonesia came into Yogyakarta to celebrate the long holiday with their families. Supposedly, the transmission is also triggered by this movement activity. In line to this, the recent study in China mentioned that international travel and trade escalate the risk of dengue transmission with imported cases (Wang et al., 2015). Other research confirmed that the number of dengue cases regarding traveller movement tends to increase (Wilder-Smith, 2013).

The satscan statistic is valuable tools to help the health authority to generate dengue prevention program, primarily in the area with a high burden of dengue but having a limited

resource as presented in malaria control (Coleman et al., 2009). This tool also supports surveillance system as early detection of dengue cluster then as a basis for attempts the prevention.

There are some primary limitations of this research. The first and foremost is data period shortage. The study would seem to be more reliable if we expanded the data period even though it is unfeasible due to the unavailability of the position (GPS) data. Another limitation would be the recently reported dengue in DHO report form. This has led to some incomplete case reports especially those without any clinical symptoms which thus did not receive any medical treatments. Therefore, it is highly recommended that the forthcoming research be conducted in a longer period involve more climate variabilities and demographic factors.

5.0 Conclusion and recommendation

Concisely, this study indicates that Satscan had an excellent performing to detect dengue cluster in Yogyakarta City. The demographic structure is suspected to be the critical factors of dengue transmission. Thus, it is expected that our result can be useful for the local government to formulate dengue control strategy.

Acknowledgement

We express our gratitude to Mr Anwar Dwi Cahyono (staff of the Yogyakarta City Health Office) and our colleague Ruri Trisasri for the technical support. The authors have received financial support for the research from the Directorate General of Higher Education, Indonesia (DIRJEN DIKTI).

The abstract of this paper had been presented in International Conference on Public Health, Solo-Indonesia, 14 – 15 September 2016.

Declaration

The author(s) declared no potential conflicts of interest on the research, authorship, and publication of this article.

Authors contribution

Author 1: Sulistyawati (SS). She developed the proposal and methodology. She also conducted the data collection and data analysis. Finally, she drafted the manuscript.

Author 2: Fardhiasih Dwi Astuti (FA). FA together with SS developed the proposal, set up the methodology, conducted data collection and data analysis. She gave feedback on the manuscript

Author 3: Aditya Lia Ramadona (AL). AL help SS and FA on the methodology and writing the manuscript.

References

Banu, S., Hu, W., Hurst, C., Guo, Y., Islam, M. Z., & Tong, S. (2012). Space-time clusters of dengue fever in Bangladesh. *Tropical Medicine & International Health : TM & IH*, *17*(9), 1086–1091. http://doi.org/10.1111/j.1365-3156.2012.03038.x

Boewono, D. T., Ristiyanto, Widiarti, & Widyastuti, U. (2012). Spatial distribution of dengue haemorrhagic fever (dhf) cases, distance index analysis and vector control alterna tive in samarinda city, east kalimantan province. *Media Litbang Kesehatan*, *22*(3), 131–137.

Coleman, M., Coleman, M., Mabuza, A. M., Kok, G., Coetzee, M., & Durrheim, D. N. (2009). guiding malaria control programmes. *Malaria Journal*, *8*(68). http://doi.org/10.1186/1475-2875-8-68

Getachew, D., Tekie, H., Gebre-michael, T., Balkew, M., & Mesfin, A. (2015). Breeding Sites of Aedes aegypti : Potential Dengue Vectors in Dire Dawa , East Ethiopia. *Interdisciplinary Perspective on Infectious Disease-Hindawi*, *2015*.

Hii, Y. L., Rocklov, J., Ng, N., Tang, C. S., Pang, F. Y., & Sauerborn, R. (2009). Climate variability and increase in intensity and magnitude of dengue incidence in Singapore. *Global Health Action*, *2*(1), 1–9. http://doi.org/10.3402/gha.v2i0.2036

Jeefoo, P., Tripathi, N. K., & Souris, M. (2011). Spatio-temporal diffusion pattern and hotspot detection of dengue in Chachoengsao province, Thailand. *International Journal of Environmental Research and Public Health*, *8*(1), 51–74. http://doi.org/10.3390/ijerph8010051

Lambrechts, L., Scott, T. W., & Gubler, D. J. (2010). Consequences of the Expanding Global Distribution of Aedes albopictus for Dengue Virus Transmission. *PLoS Neglected Tropical Diseases*, *4*(5), e646. http://doi.org/10.1371/journal.pntd.0000646

Musa, G. J., Chiang, P.-H., Sylk, T., Bavley, R., Keating, W., Lakew, B., … Hoven, C. W. (2013). Use of GIS Mapping as a Public Health Tool - From Cholera to Cancer. *Health Service Insights*, *6*, 111–116. http://doi.org/10.4137/HSI.S10471.TYPE

Photis, Y. N. (2016). Disease and Health Care Geographies : Mapping Trends and Patterns in a GIS. *Health Science Journal*, *10*(3:8), 1–9.

Pollack, L. A., Gotway, C. A., Bates, J. H., Parikh-Patel, A., Richards, T. B., Seeff, L. C., … Kassim, S. (2006). Use of the spatial scan statistic to identify geographic variations in late stage colorectal cancer in California (United States). *Cancer Causes and Control*,

17(4), 449–457. http://doi.org/10.1007/s10552-005-0505-1

Promprou, S., Jaroensutasinee, M., & Jaroensutasinee, K. (2005). Climatic Factors Affecting Dengue Haemorrhagic Fever Incidence in Southern Thailand. *Dengue Bulletin*, *29*, 41–48.

QomaruddinMunir, A., & Winarko, E. (2015). Classification Model Disease Risk Areas Endemicity Dengue Fever Outbreak based Prediction of Patients, Death, IR and CFR using Forecasting Techniques. *International Journal of Computer Applications*, *114*(2), 20–25. http://doi.org/10.5120/19950-1762

Rodriguez-Morales, A. J., Bedoya-Arias, J. E., Ramírez-Jaramillo, V., Montoya-Arias, C. P., Guerrero-Matituy, E. A., & Cárdenas-Giraldo, E. V. (2016). Using geographic information system (GIS) to mapping and assess changes in transmission patterns of chikungunya fever in municipalities of the Coffee-Triangle region of Colombia during 2014-2015 outbreak: Implications for travel advice. *Travel Medicine and Infectious Disease*, *14*(1), 62–65. http://doi.org/10.1016/j.tmaid.2015.06.009

Roiz, D., Ruiz, S., Soriguer, R., & Figuerola, J. (2014). Climatic effects on mosquito abundance in Mediterranean wetlands. *Journal Parasites and Vectors*, *7*(333), 1–13. http://doi.org/10.1186/1756-3305-7-333

State of Queensland (Queensland Health). (2015). *Queensland dengue management plan 2015–2020*. *State of Queensland*. Retrieved from https://www.health.qld.gov.au/publications/clinical-practice/guidelines-procedures/diseases-infection/governance/dengue-mgt-plan.pdf

Sulistyawati, S., Nirmalawati, T., & Mardenta, R. N. (2016). Spatial analysis of leptospirosis diseas in Bantul Regency Yogyakarta. *KEMAS*, *12*(1), 111–119.

Suyasa, I. G., Putra, N. A., & Aryanta, I. W. R. (2007). HUbungan Faktor Lingkungan dan Perilaku Masyarakat dengan Keberadaan Vektor Demam Berdarah Dengue (DBD) di Wilayah Kerja Puskesmas I Denpasar Selatan. *Ecotrophic*, *3*(1), 1–6.

Tana, S., Umniyati, S., Petzold, M., Kroeger, A., & Sommerfeld, J. (2012). Building and analyzing an innovative community-centered dengue-ecosystem management intervention in Yogyakarta, Indonesia. *Pathogens and Global Health*, *106*(8), 469–78. http://doi.org/10.1179/2047773212Y.0000000062

Wang, C., Yang, W., Fan, J., Wang, F., Jiang, B., & Liu, Q. (2015). Spatial and temporal patterns of dengue in Guangdong province of China. *Asia Pac J Public Health*, *27*(2), NP844-53. http://doi.org/10.1177/1010539513477681

Wesolowski, A., Qureshi, T., Boni, M. F., Sundsøy, P. R., Johansson, M. A., Rasheed, S. B., … Buckee, C. O. (2015). Impact of human mobility on the emergence of dengue epidemics in Pakistan. *PNAS*, *112*(38). http://doi.org/10.1073/pnas.1504964112

WHO. (2011). *Operational guide for assessing the productivity of Aedes aegypti breeding sites*. (P. Manriques-Saide, A. Che-Mendoza, N. Rizzo, B. Arana, D. Pilger, A. Lenhart, & A. Kroeger, Eds.) (1st ed.). London: WHO-TDR.

WHO. (2012). *Global Strategy for Dengue Prevention and Control 2012-2020*. (WHO, Ed.) (1st ed.). Geneva: WHO. Retrieved from http://apps.who.int/iris/bitstream/10665/75303/1/9789241504034_eng.pdf

WHO. (2015). Dengue and severe dengue. Retrieved January 1, 2016, from http://www.who.int/mediacentre/factsheets/fs117/en/

Widyaningsih, Y., & Pin, T. G. (2008). A SPACE-TIME SCAN STATISTIC TO DETECT CLUSTER ALARMS. *Makara Sains*, *12*(1), 27–30.

Wilder-Smith, A. (2013). Dengue infections in travellers. *Paediatrics and International Child Health*, *32 Suppl 1*(1), 28–32. http://doi.org/10.1179/2046904712Z.00000000050

Yogyakarta City Government. (2002). KONDISI GEOGRAFIS KOTA YOGYAKARTA. Retrieved January 1, 2016, from http://www.jogjakota.go.id/about/kondisi-geografis-kota-yogyakarta

Yogyakarta Province Tourism Agency. (2013). *Statistik Kepariwisataan 2012*. Yogyakarta: Yogyakarta Province Tourism Agency.

Yogyakarta Province Tourism Agency. (2015). *Statistik Kepariwisataan 2014*. Yogyakarta: Yogyakarta Province Tourism Agency.

Zhang, Z., Assunção, R., & Kulldorff, M. (2010). Spatial scan statistics adjusted for multiple clusters. *Journal of Probability and Statistics*, *2010*. http://doi.org/10.1155/2010/642379

EXPLORING SPATIO-TEMPORAL CLUSTER FOR DENGUE PREVENTION IN URBAN AREA OF INDONESIA

ORIGINALITY REPORT

15%

SIMILARITY INDEX

PRIMARY SOURCES

1	repository.unair.ac.id Internet	175 words — 7%
2	www.scilit.net Internet	26 words — 1%
3	eprints.qut.edu.au Internet	20 words — 1%
4	journals.sagepub.com Internet	19 words — 1%
5	media.neliti.com Internet	19 words — 1%
6	apps.state.or.us Internet	14 words — 1%
7	Inkyung Jung, Hana Lee. "Spatial cluster detection for ordinal outcome data", Statistics in Medicine, 2012 Crossref	10 words — < 1%
8	theses.gla.ac.uk Internet	10 words — < 1%
9	Liu, Yunxia, Xianjun Wang, Yanxun Liu, Dapeng Sun, Shujun Ding, Bingbing Zhang, Zhaohui Du, and Fuzhong Xue. "Detecting Spatial-Temporal Clusters of HFMD from 2007 to 2011 in Shandong Province, China", PLoS ONE, 2013. Crossref	9 words — < 1%

10	Zhang, Yingtao, Tao Wang, Kangkang Liu, Yao Xia, Yi Lu, Qinlong Jing, Zhicong Yang, Wenbiao Hu, and Jiahai Lu. "Developing a Time Series Predictive Model for Dengue in Zhongshan, China Based on Weather and Guangzhou Dengue Surveillance Data", PLoS Neglected Tropical Diseases, 2016. Crossref	9 words — < 1%
11	"6.1.2 Systems Approach and Dynamics of Dengue Infection in Singapore", INCOSE International Symposium, 2014. Crossref	9 words — < 1%
12	dc.etsu.edu Internet	8 words — < 1%
13	eprints.usm.my Internet	8 words — < 1%
14	www.tandfonline.com Internet	8 words — < 1%
15	www.mdpi.com Internet	8 words — < 1%
16	idl-bnc.idrc.ca Internet	8 words — < 1%
17	jurnal.ugm.ac.id Internet	8 words — < 1%
18	Sulistyawati Sulistyawati, Izzatun Nisa. "Climate Change and Health Teenager's Perceptions as a Basis for Interventions", International Journal of Public Health Science (IJPHS), 2016 Crossref	8 words — < 1%

EXCLUDE QUOTES	ON	EXCLUDE MATCHES	OFF
EXCLUDE BIBLIOGRAPHY	ON		