A Year of Spatio-Temporal Clusters of COVID-19 in Indonesia [similarity]

By app. ithenticate.

A YEAR OF SPATIO-TEMPORAL CLUSTERS OF COVID-19 IN INDONESIA

JUMADI JUMADI [1], VIDYA N. FIKRIYAH [1], HAMIM ZAKY HADIBASYIR [1], KUSWAJI DWI PRIYONO [1], MUHAMMAD MUSIYAM [2], ANDRI N. R. MARDIAH [3], ARIF ROHMAN [4,5], HAMZAH HASYIM [6], MOHD. HAIRY IBRAHIM [7]

[1] Faculty of Geography, Universitas Muhammadiyah Surakarta, Indonesia
[2] Department of Geography Education, Universitas Muhammadiyah Surakarta, Indonesia
[3] The Ministry of National Development Planning/BAPPENAS, Indonesia
[4] Geomatic Engineering, Institut Teknologi Sumatera (ITERA), Indonesia
[5] Centre for Spatial Analysis & Policy, School of Geography, University of Leeds, Leeds LS2 9JT, UK
[6] Faculty of Public Health, Universitas Sriwijaya, South Sumatra Province, Indonesia
[7] Universiti Pendidikan Sultan Idris, Malaysia

Manuscript received: July 12, 2021
Revised version: October 20, 2021

Jumadi J., Fikriyah V.N., Hadibasyir H.Z., Priyono K.D., Musiyam M., Mardiah A.N.R., Rohman A., Hasyim H., Ibrahim M.H., 2022. A year spatio-temporal clusters of COVID-19 in Indonesia. *Quaestiones Geographicae* 41(2), Bogucki Wydawnictwo Naukowe, Poznań, pp. 139–151. 7 figs, 5 tables.

ABSTRACT: Coronavirus disease-2019 (COVID-19) in Indonesia began to appear on March 2, 2020 and led to a number of fatalities. Spatial analysis is important to study the spatio-temporal trend of COVID-19 cases and fatalities to get a better understanding of the spread as well as to mitigate it. However, such a comprehensive study at national level is not to be seen in Indonesia with limited health infrastructure. This study aims to analyse the spatio-temporal distribution and clusters of COVID-19 in Indonesia for a year period. COVID-19 cases, as well as the fatalities as a consequence of this disease, were collected from the government through publicly shared data. A geographic information system (GIS) was used to manage and analyse the data on demographics, cases, and fatalities. The case fatality rate (CFR) was produced based on the number of cases and deaths per province weekly. The spatio-temporal data of both cases and fatalities were generated from the data. Finally, K-means clustering was employed to classify the cluster of Indonesia based on the proportion of vulnerable age groups, cases, and CFR. The results show that most of the provinces in Indonesia are affected by COVID-19, but the fatalities are not distributed evenly throughout the country. Based on the K-means clustering, two provinces are classified as moderate, namely the Province of East Kalimantan and North Kalimantan. The Province of Jakarta is classified as high, because the vulnerable age group there is highly correlated with the number of cases and deaths.

KEYWORDS: COVID-19, spatio-temporal analysis, epidemic mapping, pandemic, Indonesia

Corresponding author: Jumadi Jumadi, Faculty of Geography, Universitas Muhammadiyah Surakarta, Jl. A. Yani Tromol Pos 1 Pabelan, Surakarta, 57162 INDONESIA; e-mail: jumadi@ums.ac.id

Introduction

The first case of coronavirus disease-2019 (COVID-19) was recorded by the World Health Organization (WHO) on December 31, 2019, in Wuhan, Hubei Province, China. As of January 3, 2020, cases of the new disease had spread to 44 people in China, and 10 days later, the disease

https://doi.org/10.2478/quageo-2022-0013
ISSN 2082-2103, eISSN 2081-6383

began to spread to other countries (Hadibasyir et al. 2020; Kang et al. 2020). By November 11, 2020, the cases increased rapidly to 51,251,715, including 1,270,930 deaths within 220 countries, areas, or territories (WHO, 2020a).

COVID-19 was initially found in Wuhan, China, and its surroundings. The disease began to spread on a broader scale, and so it became an epidemic in a very short time. Then, the disease spread out globally and was recognised as a pandemic from March 2020. COVID-19, or coronavirus disease, arises due to a new type of coronavirus discovered in 2019. Coronavirus is a family of viruses that causes respiratory disease in humans and animals, ranging from the common cold to other more severe diseases such as MERS and SARS (WHO, 2020b). While COVID-19 tends to be less dangerous for most people who can recover without hospitalisation, it can get worse for the elderly as well as those with chronic health problems. Until 2021, there were many mutation types of COVID-19, one of which is called the delta variant from India. This delta variant spread approximately 97% more rapidly than the first variant. The mutations of COVID-19 viruses also make this disease lethal to the elderly and younger people alike.

Since the first case in 2019, the spread of COVID-19 has become increasingly uncontrollable throughout the world. Countries across Asia, particularly Southeast Asia, reported a COVID-19 outbreak with a large number of daily positive cases (on average 28,800 in June 2021), making this region a hotspot of the disease (Chookajorn et al. 2021). The new delta variant contributed also to the rising cases in Bangladesh, Malaysia, Pakistan, Thailand, and Vietnam (BBC, 2021).

Meanwhile, Indonesia started to find cases on March 2, 2020. COVID-19 in Indonesia spread relatively quickly, which initially had only two positive cases in March, then it grew to 10,118 confirmed positive cases in April 30 (Kementrian Kesehatan Republik Indonesia, 2020). The government of Indonesia then promoted social distancing to decrease people's mobility (Mas'udi, Winanti 2020; Amin et al., 2021) and created a response acceleration task force for coordination and prevention of the pandemic at national and village levels (BNPB & Universitas Indonesia 2020; Permatasari et al. 2021; Saputra et al. 2022). Even though the development of the COVID-19 case in Indonesia is quite alarming, there are still many people who violate government regulations to maintain physical distance and avoid out-of-home activities for varied purposes, ranging from the need of earning money to the need of doing activities to get rid of boredom. There are even some people who do not believe in the dangers of COVID-19. The large number of Indonesia's population, which in 2018 is estimated to reach 265,015,300 people (ASEAN Secretariat 2019), coupled with the presence of citizens who do not comply with government regulations, will certainly be dangerous because the potential for virus transmission can be higher and more people can get infected or become severely ill. Spatio-temporal data of COVID-19 is important to understand the pandemic appropriately.

Although previous studies attempted to deliver the trend of COVID-19 cases in Indonesia, this research was based upon data from the first six months and did not examine the similarity condition of cases and demographic status (Aisyah et al. 2020). Therefore, the development of the COVID-19 case is essential to present the spatio-temporal dynamics of COVID-19 data within a year of the observation period. Areas that have a higher number of COVID-19 cases need attention so that the government can anticipate it and bring the number of cases down to a manageable level. The comparison of regional conditions with the ratio of essential cases should be made to know which conditions are conducive to a higher number of cases so that other areas in a similar situation can be kept on alert.

The purpose of this study is to analyse the spatio-temporal distribution and clusters of COVID-19 in Indonesia for a year period based on the number of cases, number of deaths, the case fatality rate (CFR), and vulnerable groups using a clustering algorithm. We present clustering analysis to classify the provinces with similar characteristics in cases, number of deaths, CFR, and vulnerable groups. Therefore, appropriate mitigation to prevent further growth of COVID-19 cases can be formulated based on regional characteristics.

Method

This study was conducted in Indonesia, which is administratively divided into 34 provinces (Fig. 1). We used geographic information

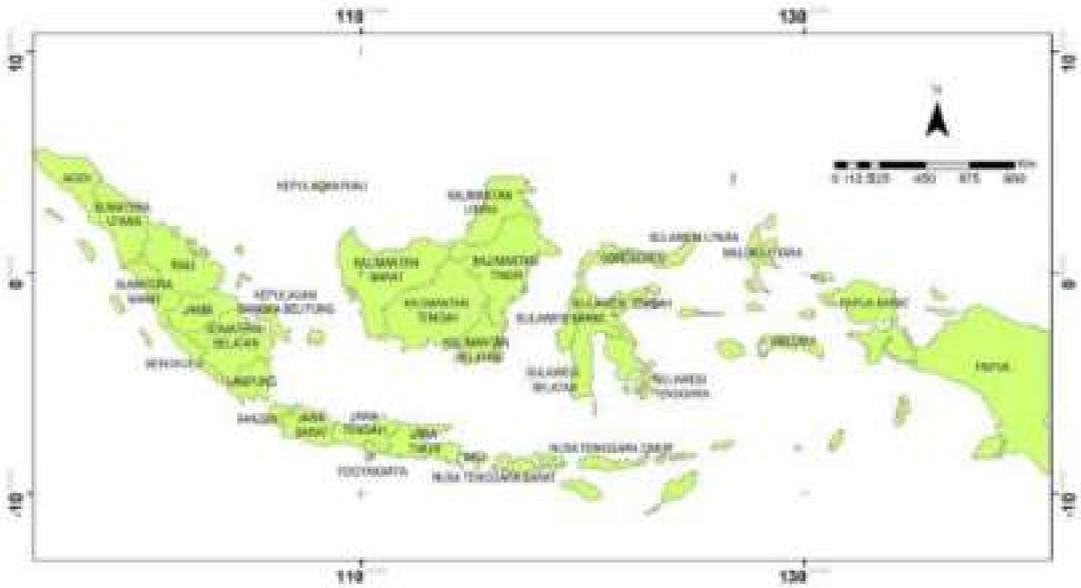

Fig. 1. Area of study.
Source: own elaboration.

system (GIS)-based spatial and statistical analysis to provide both the spatio-temporal distribution of Covid-19 data and cluster classification. The general overview of the framework used in this study is presented in Fig. 2. The framework mainly consists of three parts: spatio-temporal analysis of CFR and vulnerable group mapping based on the age proportion, and clustering analysis based on the number of cases, the number of deaths, CFR, and vulnerable groups.

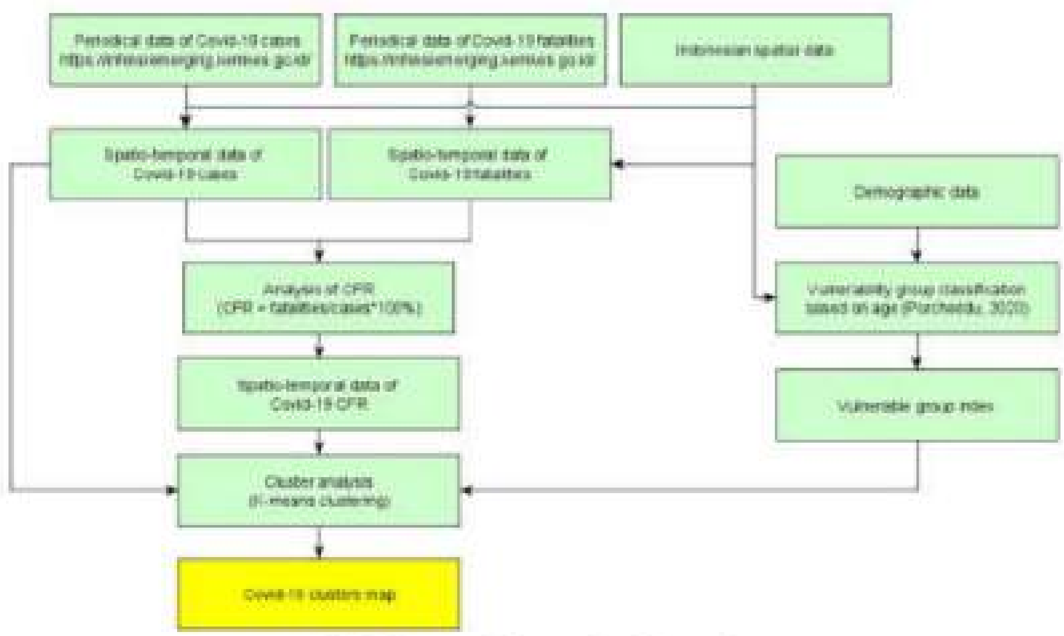

Fig. 2. The general framework of the study.
Source: own elaboration.

This study was conducted using data on the number of COVID-19 cases in Indonesia from March 2020 to March 2021, obtained from the Current Situation Report by the Ministry of Health of the Republic of Indonesia. The data on COVID-19 was downloaded from https://infemerging.kemkes.go.id/. We compiled the data in various forms into a standardised excel file and brought it into GIS. The tabular data of COVID cases and the fatalities were joined with spatial data on Indonesia to produce the spatio-temporal data.

The map with the cumulative number of COVID-19 cases and deaths per province was classified in such a way that the class length was calculated using the logarithmic method. Afterward, the number of deaths was divided by the positive cases and was presented in percentage to calculate the CFR (WHO, 2020b). The values of CFR were grouped using the natural breaks (Jenks) method. The maps were divided into three classes representing the number of high, medium, and low numbers; then, one class was added to represent areas with no cases or 0 cases so that a total of four classes are on the map.

The population's vulnerability (VLN) was calculated considering the age group following the study of Porcheddu et al. (2020), where the percentage of vulnerable people within each group was calculated based on the following rates: 30–59 (0.2), 60–69 (0.4), 70–70 (1.3), >80 (3.6). The VLN index was defined based on the proportion of the total vulnerable population of all groups within the population.

Data analysis was performed using the spatio-temporal descriptive method on the compiled maps. The spatio-temporal analysis is intended to observe changes in a particular place within a specified period, from March 2020 to March 2021. The analysis was also carried out by searching for various information from news explaining the reasons for the increase, the high number of COVID-19 infection cases and demographic conditions in an area.

Lastly, the K-means clustering algorithm was applied to derive an insight regarding regional homogeneity. Variables included in the cluster analysis embrace VLN, CFR, cumulative cases per 1 million of the population (as at March 1, 2021), and the number of deaths per 1 million of the population (as at March 1, 2021).

Results and discussion

The spatio-temporal dynamics of COVID-19 cases

This study was compiled using data on the number of COVID-19 cases from March 2, 2020 to March 1, 2021. In order not to compile too much data on maps, tables and graphs, the development of issues was not seen per day but per week.

The development of COVID-19 cases during the observation period is provided in Fig. 3. In general, this figure shows that the COVID-19 case in Indonesia began in Java Island around early March. The cases continued to spread to other islands rapidly within only one week, while the cases became higher in Java Island. In late April, the case of COVID-19 has spread throughout Indonesia, with the number of positive cases from 43 to 1,739. This number got worse in the middle of May, when positive cases reached at least 1,760 cases in the eastern part of Java, followed by the western and central part of Java, south Sumatera, the southern part of Kalimantan and Sulawesi in June. It took only 15 weeks of virus transmission for Java Island (excluding the Banten Province) to transform from a green zone to a red zone. The high positive cases are then transmitted to Papua and other parts of Sumatera starting from July. At the end of observation time (March 2021), Indonesia was almost covered entirely by high positive cases of COVID-19 (i.e. red zone; except the western part of Kalimantan which was still a yellow zone).

The spatio-temporal dynamics of COVID-19 CFR and VLN

Regarding the number of deaths due to COVID-19 (Fig. 4) and the CFR (Fig. 5), it can be seen that death cases have a similar pattern to the positive cases from March to the middle of May. Surprisingly, despite the high positive cases, the number of deaths in West Java remained low from May 25 to August 3. Also, death cases in Papua stayed low regardless of the high number of positive cases. In line with the positivity cases pattern map (Fig. 3), in the end, the population of the Java and Sumatera Islands has also experienced the most severe fatalities.

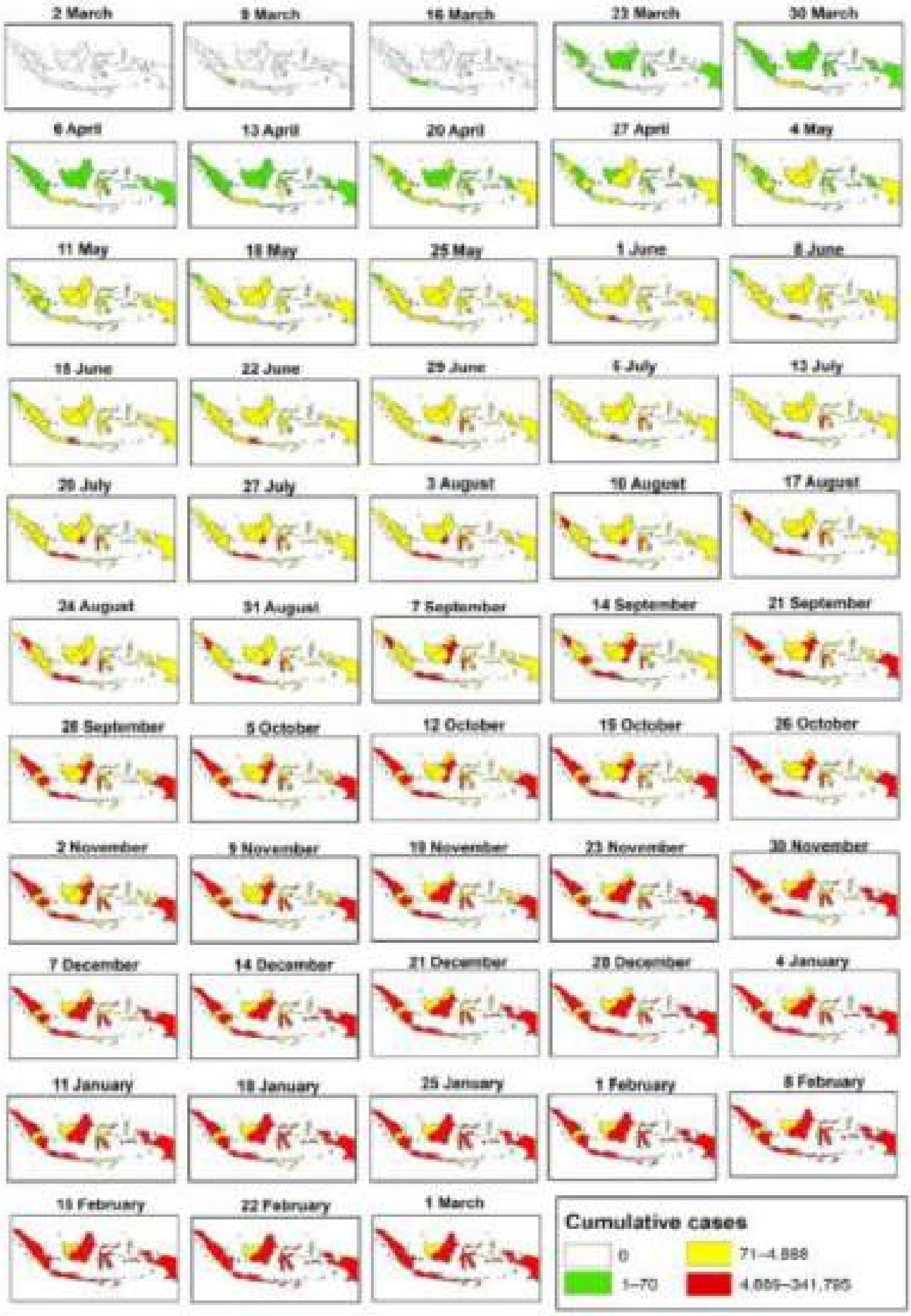

Fig. 3. COVID-19 cases between March 2020 and March 2021.
Source: own elaboration.

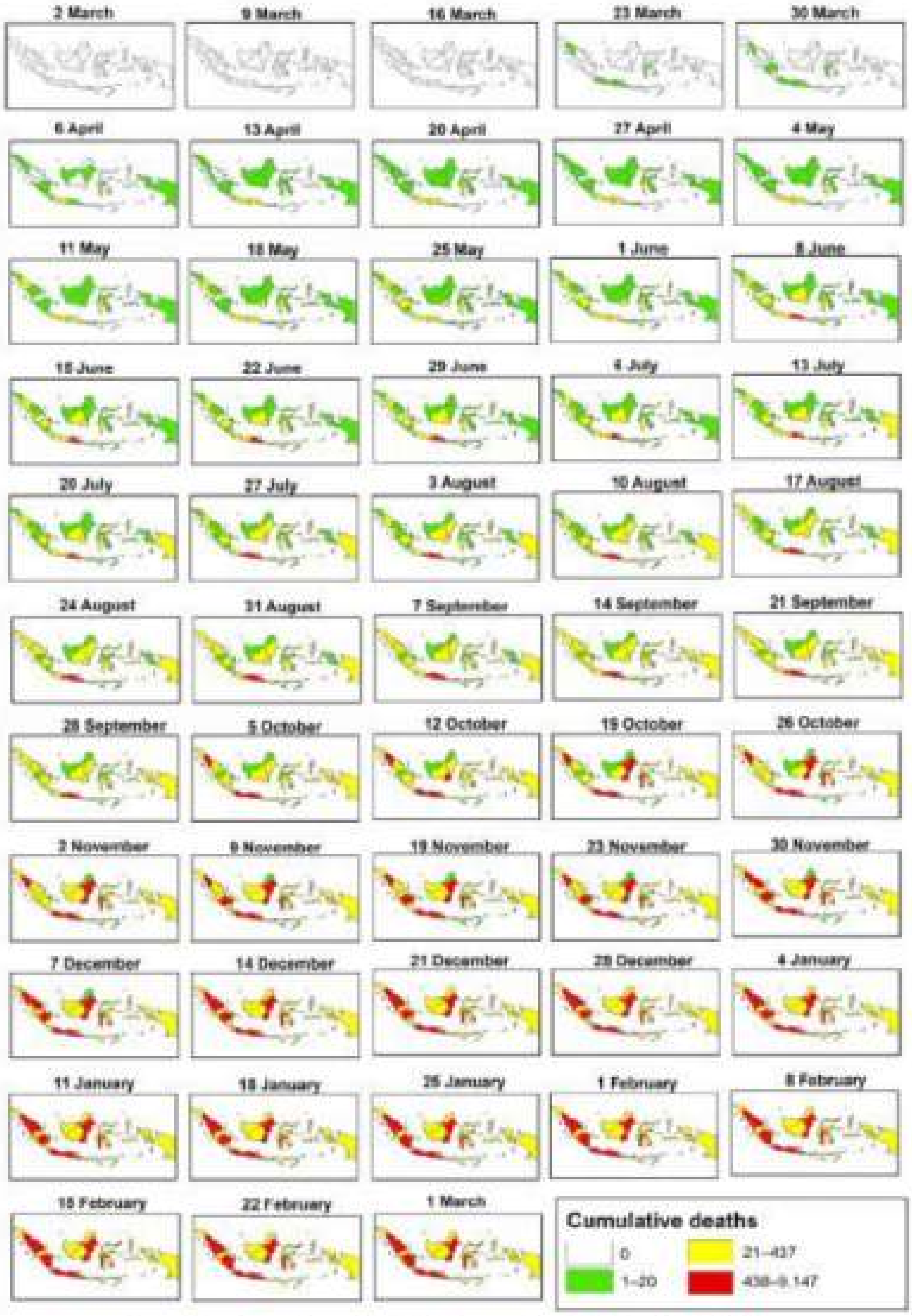

Fig. 4. Death cases from COVID-19 between March 2020 and March 2021.
Source: own elaboration.

Fig. 5. CFR of COVID-19 between March 2020 and March 2021.
CFR – case fatality rate.
Source: own elaboration.

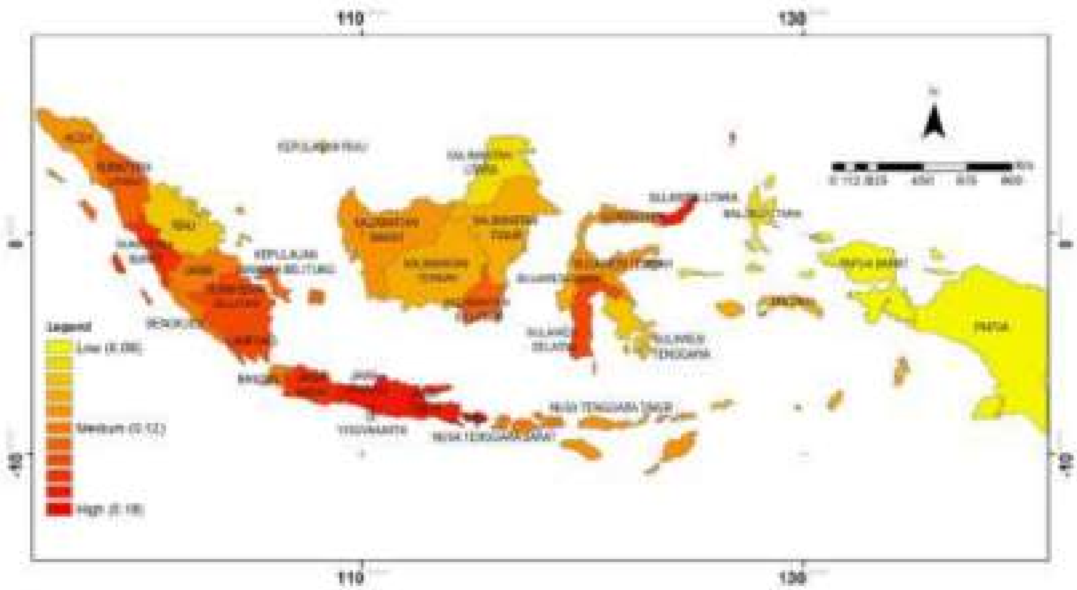

Fig. 6. VLN of COVID-19 between March 2020 and March 2021.
VLN – vulnerability.
Source: own elaboration.

The VLN index based on the proportion of vulnerable age groups to COVID-19 (Porcheddu et al. 2020) is presented in Fig. 6. The figure shows that Java has the highest VLN compared to other islands, especially in Java's west, central, and east. On the other hand, the eastern part of Indonesia, such as Papua and Maluku, are relatively less vulnerable compared to the others.

Regional cluster based on K-means analysis

Clusters of COVID-19 in Indonesia were obtained through the calculation of K-means. The calculation used data on VLN, CFR, cumulative cases per 1 million of the population (as at March 1, 2021), and the number of deaths per 1 million of the population (as at March 1, 2021). Based on that data, the K-means produced three clusters (See classification in Table 1). Fig. 7 shows the distribution of the COVID-19 cluster, while Table 1 shows the characteristics of the three clusters, and Table 2 presents the detailed result from the K-means calculation.

The classification of clusters is provided in Table 3, accompanied by the descriptive statistics in Table 4. Cluster 1 represents the class of moderate VLN with low cumulative COVID-19 cases per 1 million of the population, a low death rate per 1 million of the population, and a high CFR. Cluster 2 is for the class with low VLN and a moderate level of cumulative cases per 1 million of the population, the death rate per 1 million of the population, and CFR, while cluster 3 represents the class of low CFR with high VLN, cumulative

Table 1. Attributes of clusters and summary.

Characteristics	Cluster 1	Cluster 2	Cluster 3
VLN	Moderate	Low	High
CCS per 1 million of population	Low	Moderate	High
Death per 1 million of population	Low	Moderate	High
CFR	High	Moderate	Low
Members of clusters	Thirty-one other provinces (Table 2)	Two provinces: East Kalimantan and North Kalimantan	One province: DKI Jakarta

CFR – case fatality rate; VLN – vulnerability; CCS – cumulative cases
Source: own study.

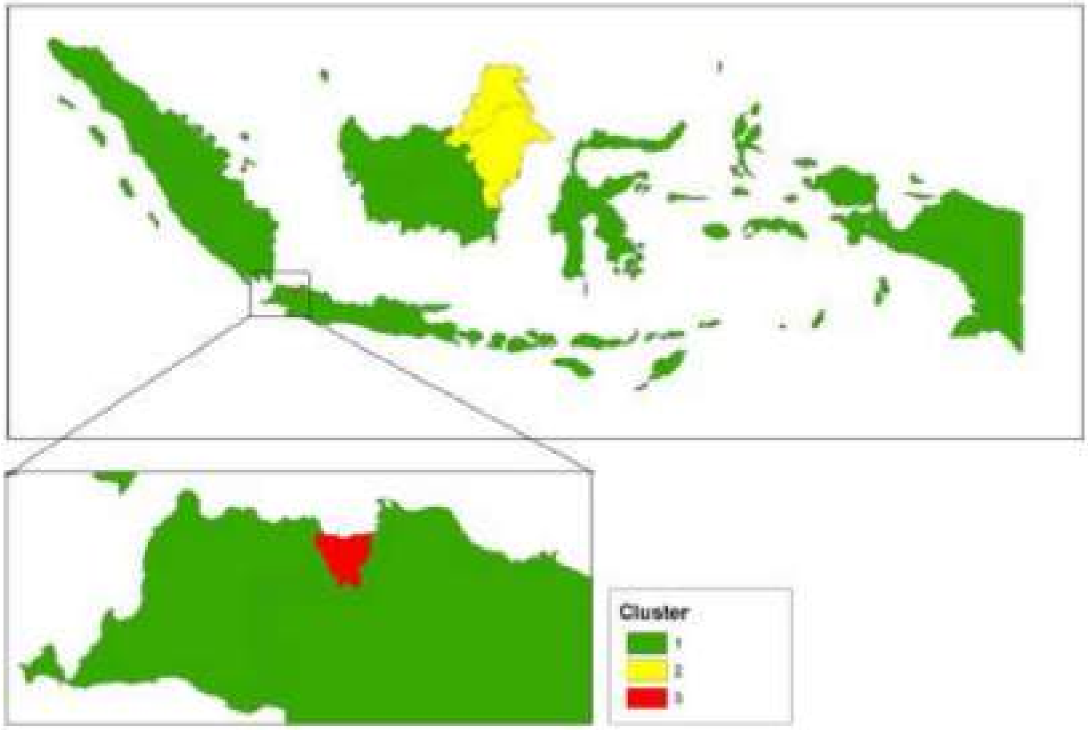

Fig. 7. The cluster of COVID-19 based on VLN, cumulative cases, death cases, and CFR in every province.
VLN – vulnerability; CFR – case fatality rate.
Source: own elaboration.

Table 2. Cluster membership of COVID-19 in every province.

No	Province	VLN	CCS per 1 mi pop	Death per 1 mi pop	CFR	Cluster
1	Aceh	0.24	1,810.82	72.87	4.02	1
2	Bali	0.70	7,958.33	214.58	2.70	1
3	Banten	0.28	2,478.74	51.60	2.08	1
4	Kepulauan Bangka Belitung	0.30	5,050.68	76.71	**1.52**	1
5	Bengkulu	0.26	2,455.72	73.13	2.98	1
6	D. Yogyakarta	1.00	7,620.44	185.83	2.44	1
7	Jambi	0.27	1,546.20	23.38	**1.51**	1
8	West Kalimantan	0.24	857.67	6.10	**0.71**	1
10	Central Kalimantan	0.19	5,215.36	135.56	2.60	1
11	South Kalimantan	0.30	5,415.97	179.85	3.32	1
13	Kepulauan Riau	0.17	4,230.58	106.80	2.52	1
14	West Nusa Tenggara	0.27	1,652.26	64.29	3.89	1
15	South Sumatera	0.35	1,885.48	91.62	4.86	1
16	West Sumatera	0.44	5,281.01	117.00	2.22	1
17	North Sulawesi	0.61	5,733.21	188.93	3.30	1
18	North Sumatera	0.30	1,666.62	56.62	3.40	1
19	South East Sulawesi	0.15	3,837.40	74.05	1.93	1
20	South Sulawesi	0.39	6,211.58	92.94	**1.50**	1
21	Central Sulawesi	0.24	3,377.59	86.62	2.56	1
22	Lampung	0.40	1,399.33	72.14	5.16	1
23	Riau	**0.14**	4,922.22	119.72	2.43	1
24	North Maluku	**0.11**	3,114.84	88.28	2.83	1
25	Maluku	0.19	3,775.14	56.76	**1.50**	1

No	Province	VLN	CCS per 1 mi pop	Death per 1 mi pop	CFR	Cluster
26	West Papua	0.00	6,584.96	111.50	**1.69**	1
27	Papua	**0.04**	3,973.02	41.16	**1.04**	1
28	West Sulawesi	0.20	3,685.92	73.24	1.99	1
29	East Nusa Tenggara	0.25	1,742.40	49.16	2.82	1
30	Gorontalo	0.23	4,100.85	116.24	2.83	1
32	West Java	0.44	4,410.07	48.97	**1.11**	1
33	Central Java	0.67	4,208.24	183.16	4.35	1
34	East Java	0.79	3,191.54	224.91	7.05	1
9	East Kalimantan	0.18	14,808.49	347.21	2.34	2
12	North Kalimantan	0.12	14,008.57	211.43	**1.51**	2
31	Dki Jakarta	0.37	32,366.76	524.62	1.62	3

The bold number indicates a particular variable value that surpasses other cluster centres.
VLN – vulnerability; CCS – cumulative cases; CFR – case fatality rate
Source: own calculation.

cases, and death rate. As shown in Fig. 7, almost all provinces in Indonesia are classified into cluster 1. Only the Province of East Kalimantan and North Kalimantan are grouped in cluster 2, and only the Province of Jakarta is in cluster 3.

K-means clustering classifies a province into a cluster by considering the four variables that have been mentioned. There was no overlapping value for cumulative cases and death rate over clusters. However, some anomalous conditions are found, where the value of a variable in one cluster exceeds the value of the centre of another cluster. Anomalous conditions in cluster 1 with a VLN value <0.15 (centre of cluster 2) were found in Riau (0.14), North Maluku (0.11) and Papua (0.04). In addition, anomalous conditions in cluster 1 with CFR values <1.93 (centre of cluster 2) were found in Kepulauan Bangka Belitung (1.52), Jambi (1.51), West Kalimantan (0.71), South Sulawesi (1.50), Maluku (1.50), West Papua (1.69), Papua (1.04), and West Java (1.11).

Table 3. Final cluster centre.

Final Cluster Centre			
Variables	Cluster		
	1	2	3
VLN	0.33	0.15	0.37
CCS per 1 million of population	3,851.43	14,408.53	32,366.76
Death per 1 million of population	99.48	279.32	524.62
CFR	2.74	1.93	1.62

CFR – case fatality rate; VLN – vulnerability, CCS – cumulative cases
Source: own calculation.

Discussion

In this study, the spatio-temporal trend of COVID-19 cases in Indonesia was analysed. As seen in the results, the cases and death rate were high in Java Island, especially in the Province of West Java, Central Java, and East Java. However, from June, the cases spread outside Java, starting from Sulawesi, Kalimantan, and Sumatera Island (*See* Section "The spatio-temporal dynamics of COVID-19 cases" and Fig. 3). This tremendous change was observed right after the celebration of Eid Day on May 24–26, 2020, which is followed by annual leaves and school holidays. Although the central and local authorities (i.e. Province of Jakarta and other destination provinces) have already applied some restrictions for people traveling between cities during those

Table 4. Descriptive statistics for each cluster.

Cluster	VLN			CCS per 1 million of population			Death per 1 million populations			CFR		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
1	0.00	0.33	1.00	857.67	3,851.43	7,958.33	6.10	99.48	224.91	0.71	2.74	7.05
2	0.12	0.15	0.18	14,008.57	14,408.53	14,808.49	211.43	279.32	347.21	1.51	1.93	2.34
3	0.37	0.37	0.37	32,366.76	32,366.76	32,366.76	524.62	524.62	524.62	1.62	1.62	1.62

CCS – cumulative cases; CFR – case fatality rate; VLN – vulnerability.
Sources: Analysed from www.covid19.go.id and gis.dukcapil.kemendagri.go.id.

Table 5. Indonesian holidays and the increasing number of positive cases.

Type of holidays	Baseline*	A week after	2 weeks after
Eid day (May 18–24, 2020)	4,757	Increase 49%	Increase 60% (in accumulative)
The birth of Prophet Muhammad (October 28–30, 2020)	23,072	Increase 32%	Increase 59% (in accumulative)
Natal and New Year's Eve (December 25-31, 2020)	50,360	Increase 63%	Increase 71% (in accumulative)

Sources: compiled from www.covid19.go.id; Litbang Kompas (2021), Chryshna (2021).
Note: *Number of cases during the holidays.

weeks (e.g. PSBB (Social Lockdown)[1] and reducing the annual leaves duration for government employees), yet this regulation was not applied simultaneously for all provinces (Muhyiddin 2020) and the mobility of people could not be anticipated and well-managed by the joint central and local government's network (Nurdin et al. 2022). Therefore, as mentioned in the study of Nouvellet et al. (2021), the restriction of human mobility is important to control the COVID-19 transmission. From the following data, some changes can be observed due to several types of holidays in Indonesia (Table 5).

On the other hand, the government claimed that the sharp increase was not solely due to the high mobility of people during the holidays but also due to the government's increased capacity in conducting tests and tracing to the positive cases. Although it is reported that the data registration of contact and tracing was not going well in the early phase (Bappenas 2021), the government then succeeded in increasing the specimen testing capacity by 10,000 tests per day (Antaranews 2020). Indonesia's testing capacity as of the end of November 2020 has reached 90.64%. With the increasing number of laboratories and universities capable of testing, the government was optimistic in achieving WHO standards (Indonesia COVID-19 Handling Task Force 2020).

In terms of the COVID-19 cluster cases, 31 provinces are classified into cluster 1 with moderate VLN, low cumulative cases, low death cases, and high CFR. On the other hand, cluster 3 was only given to DKI Jakarta with a low CFR and high level of VLN, cumulative cases, and death rate. In contrast to Malaysia (Aw et al. 2021), the high number of cases in Jakarta might be related to its high population density. Also, the observation of low CFR in Jakarta might be due to the increased number of health facilities because of its status as the capital of Indonesia. The Province of Jakarta has a relatively better test and tracing capacity. In addition to Jakarta, by December 2020, another fifteen provinces had better tests and tracing capacity. Among them three provinces have consistently achieved WHO standards, namely Provinces of Jakarta, East Kalimantan and Papua. The other provinces referred to Riau, West Papua, West Sumatra, North Sulawesi, DI Yogyakarta, Bali, Central Java, South Kalimantan, Banten, Central Kalimantan, South Sulawesi, Gorontalo and West Sulawesi (Indonesia COVID-19 Handling Task Force 2020). Due to the varied level of testing and tracing capacity, further studies are still required, particularly about the relationship between COVID-19 cases, testing and tracing capacity, and the distribution of health facilities in every province (Siegel, Mallow 2021).

Based on the K-means clustering results, cumulative cases and death rates did not overlap from one cluster to the other clusters. This shows that those variables were the main determinant in classifying the characteristics of the Covid-19 severity in a province. Therefore, the government can prepare mitigation measures for handling Covid-19 by emphasising cumulative cases and death rate conditions over provinces in Indonesia. Furthermore, in terms of VLN, the proportion of age group seems associated with the number of positive and death cases, which are also demonstrated by Zhu et al. (2021). By the time the study report was written, the COVID-19 cases were predominantly caused by variant B.1.466.2, B.1.470, B.1.1.398 and B.1.459 (CNN Indonesia, 2021). Through spatial patterns, we can observe that the increased fatalities are grouped together with the characteristic of the vulnerable age group,

[1] According to Government Regulation (Peraturan Pemerintah) No. 21 Year 2021, the focus of the large scale of social restriction policy in Indonesia (in Bahasa known as *Pembatasan Sosial Berskala Besar/PSBB*) was to strengthen the social distancing. This policy aims to reduce crowds not sufficiently adhering to health protocol, and is expected to reduce the spread of the coronavirus.

that is between age 30 to 59 (covid19.go.id 2020). However, in 2021 the new variants are claimed to be more aggressive and infectious and easily spread to many regions in Indonesia.

Conclusions

The dynamic distribution of COVID-19 in Indonesia was analysed in this study using spatial and temporal perspectives. Observation using secondary data was conducted from March 2020 to March 2021. The results show that Indonesia experienced COVID-19 cases starting from early March in Java, and it continued to spread to other regions by the end of March. This spatial pattern of high positive cases was correlated to the VLN condition. However, it was not always followed by the pattern of the fatality. The K-means clustering result shows that the Province of Jakarta has a high VLN, cumulative positive cases, and death cases but a low CFR. For further studies, some other indicators could be included for a more comprehensive analysis, such as the distribution and capacity of health facilities.

Acknowledgment

This research is funded by HIT Program Universitas Muhammadiyah Surakarta 2021.

References

Aisyah D.N., Mayadewi C.A., Diva H., Kozlakidis Z., Siswanto; Adisasmito W., 2020. A spatial-temporal description of the SARS-CoV-2 infections in Indonesia during the first six months of outbreak. *PLOS ONE*, 15(12): e0243703. DOI 10.1371/JOURNAL.PONE.0243703.

Amin C., Priyono P., Umrotun U., Fatkhiyah M., Sufahani S.F., 2021. Exploring the prevalence of protective measure adoption in mosques during the COVID-19 pandemic in Indonesia. *Sustainability* 13(24): 13927. DOI 10.3390/su132413927.

Antaranews, 2020. Pemerintah Jelaskan Penyebab Lonjakan Penambahan Kasus COVID-19 (The government explains the causes of the spike in the addition of COVID-19 cases). Online: https://www.antaranews.com/berita/1547124/pemerintah-jelaskan-penyebab-lonjakan-penambahan-kasus-covid-19 (accessed: 30 October 2021).

ASEAN Secretariat, 2019. *ASEAN Statistical Yearbook 2019*. The ASEAN Secretariat, Jakarta.

Aw S.B., Teh B.T., Ling G.H.T., Leng P.C., Chan W.H., Ahmad M.H., 2021. The COVID-19 pandemic situation in Malaysia: Lessons learned from the perspective of population density. *International Journal of Environmental Research and Public Health* 18(12): 6566. DOI 10.3390/IJERPH18126566.

Bappenas (The Ministry of National Development Planning), 2021. Studi Pembelajaran Penanganan Covid-19 Indonesia (1st ed.).

BBC, 2021. *Delta variant: Which Asian countries are seeing rising cases? – BBC News*. Online: https://www.bbc.com/news/world-asia-53420537 (accessed: 20 September 2021).

BNPB & Universitas Indonesia, 2020. Indonesia's experience in Covid-19 Control. BNPB & Universitas Indonesia. Online: https://drrc.ui.ac.id/drrc/?page_id=1723 (accessed: 11 September 2021).

Chookajorn T., Kochakarn T., Wilasang C., Kotanan N., Modchang C., 2021. Southeast Asia is an emerging hotspot for COVID-19. *Nature Medicine* 27(9): 1495–1496. DOI 10.1038/s41591-021-01471-x.

Chryshna M., 2021. Lonjakan Kasus COVID-19 Pasca Liburan Lebaran (The spike in COVID-19 cases after the Eid holiday). Online: https://kompaspedia.kompas.id/baca/paparan-topik/lonjakan-kasus-covid-19-pasca-libur-lebaran-2021 (accessed: 11 September 2021).

CNN Indonesia, 2021. *LIPI: Varian Lokal B.1.466.2 Masif Sebelum Delta Menyerang* (LIPI: Local Variant B.1.466.2 massive before Delta hits). Online: https://www.cnnindonesia.com/teknologi/20210729155943-199-673887/lipi-varian-lokal-b14662-masif-sebelum-delta-menyerang (accessed: 1 September 2021).

Covid19.go.id, 2020. Kasus Meninggal Akibat COVID-19 Paling Banyak Usia 30–59 Tahun – Berita Terkini | Covid19.go.id. Online: https://covid19.go.id/p/berita/kasus-meninggal-akibat-covid-19-paling-banyak-usia-30-59-tahun (accessed: 11 September 2021).

Hadibasyir H.Z., Rijal S.S., Sari D.R., 2020. Comparison of land surface temperature during and before the emergence of Covid-19 using modis imagery in Wuhan City, China. *Forum Geografi* 34(1): 1–15. DOI 10.23917/forgeo.v34i1.10862.

Indonesia COVID-19 Handling Task Force, 2020. *Kapasitas Testing 16 Provinsi Capai Target WHO*. Online: https://covid19.go.id/p/berita/kapasitas-testing-16-provinsi-capai-target-who.

Kang D., Choi H., Kim J.-H., Choi J., 2020. Spatial epidemic dynamics of the COVID-19 outbreak in China. *International Journal of Infectious Diseases* 94: 96–102. DOI 10.1016/j.ijid.2020.03.076.

Kementrian Kesehatan Republik Indonesia, 2020. *Situasi Terkini Perkembangan Novel Coronavirus (COVID-19) Update 3 Maret 2020*. Online: https://infeksiemerging.kemkes.go.id/download/Situasi_Terkini_Perkembangan_COVID-19_per_2_Maret_2020.pdf.

Mas'udi W., Winanti P.S., 2020. *Tata Kelola Penanganan COVID-19 di Indonesia: kajian Awal*, 1st edn.. Gadjah Mada University Press.

McKeever A., 2020. Coronavirus is officially a pandemic. Here's why that matters. Online: https://www.nationalgeographic.com/science/2020/02/how-coronavirus-could-become-pandemic-and-why-it-matters/.

Muhyiddin M., 2020. Covid-19, new normal, dan Perencanaan Pembangunan di Indonesia. *Jurnal Perencanaan Pembangunan: The Indonesian Journal of Development Planning* 4(2): 240–252. DOI 10.36574/jpp.v4i2.118.

Nouvellet P., Bhatia S., Cori A., Ainslie K.E.C., Baguelin M., Bhatt S., Boonyasiri A., Brazeau N.F., Cattarino L., Cooper L.V., Coupland H., Cucunuba Z.M., Cuomo-Dannenburg G., Dighe A., Djaafara B.A., Dorigatti I., Eales O.D., van Elsland S.L., Nascimento F.F., FitzJohn R.G., Gaythorpe K.M., Geidelberg L., Green W.D., Hamlet A., Hauck K., Hinsley W., Imai N., Jeffrey B., Knock E., Laydon D.J., Lees J.A., Mangal T., Mellan T.A., Nedjati-Gilani G., Parag K.V., Pons-Salort M., Ragonnet-Cronin M., Riley S., Unwin H.J.T., Verity R., Vollmer M.A.C., Volz E., Walker P.G.T., Walters C.E., Wang H., Watson O.J., Whittaker C., Whittles L.K., Xi X., Ferguson N.M., Donnelly C.A., 2021. Reduction in mobility and COVID-19 transmission. *Nature Communications* 12(1): 1–9. DOI 10.1038/s41467-021-21358-2.

Nurdin M.R., Noveria A., Shalih O., Mardiah A.N., 2022. *National response to the global pandemic of Covid-19: Evidence from Indonesia, Malaysia, and Vietnam. In Post-Disaster Governance in Southeast Asia* (pp. 13–38). Springer, Singapore.

Porcheddu R., Serra C., Kelvin D., Kelvin N., Rubino S., 2020. Similarity in Case Fatality Rates (CFR) of COVID-19/SARS-COV-2 in Italy and China. *Journal of Infection in Developing Countries* 14(2): 125–128.

Permatasari A., Suherningtyas I., Febriarta E., Wiguna P., 2021. Analysis of vulnerability to transmission of the Covid-19 based on building function at Padukuhan Mancasan Kleben, Pandowoharjo, Sleman, Yogyakarta. *Forum Geografi* 35(2): 169–178. DOI 10.23917/forgeo.v35i2.13755.

Saputra A., Setiawan W., Arif M., Sriyono S., Nurmalasari L, Dijaya R., Ulinuha A., Hermawan S., 2022. Non-Medical risk assessment of COVID-19 in parts of Central and East Java, Indonesia. *Quaestiones Geographicae* 41(1): 147–169. DOI 10.2478/quageo-2022-0010.

Siegel R.M., Mallow P.J., 2021. The impact of COVID-19 on vulnerable populations and implications for children and health care policy. *Clinical Pediatrics* 60(2): 93–98. DOI 10.1177/0009922820973018.

World Health Organization (WHO), 2020a. Estimating mortality from COVID-19 [Internet]. 2020 [cited 2020 Nov 11]. Online: https://covid19.who.int/.

World Health Organization (WHO), 2020b. Novel Coronavirus (2019-nCoV) situation report – 1. Online: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200121-sitrep-1-2019-ncov.pdf.

Zhu M., Kleepbua J., Guan Z., Chew S.P., Tan J.W., Shen J., Latthitham N., Hu J., Law J.X., Li L., 2021. Early spatiotemporal patterns and population characteristics of the COVID-19 pandemic in Southeast Asia. *Healthcare* 9(9): 1220. DOI 10.3390/HEALTHCARE9091220.

A Year of Spatio-Temporal Clusters of COVID-19 in Indonesia [similarity]

ORIGINALITY REPORT

11%
SIMILARITY INDEX

PRIMARY SOURCES

1	repec.editool.com Internet	266 words — 6%
2	doaj.org Internet	71 words — 2%
3	pressto.amu.edu.pl Internet	44 words — 1%
4	bn.org.pl Internet	32 words — 1%
5	"Post-Disaster Governance in Southeast Asia", Springer Science and Business Media LLC, 2022 Crossref	30 words — 1%
6	ri.conicet.gov.ar Internet	29 words — 1%
7	www.researchgate.net Internet	16 words — < 1%
8	www.mdpi.com Internet	15 words — < 1%
9	Irma Yuliana, Hardika Dwi Hermawan, Harun Joko Prayitno, Koesomo Ratih et al. "Computational	14 words — < 1%

Thinking Lesson in Improving Digital Literacy for Rural Area Children via CS Unplugged", Journal of Physics: Conference Series, 2021

Crossref

---

10 www.scielo.br

Internet

12 words — < 1%

EXCLUDE QUOTES	ON	EXCLUDE SOURCES	OFF
EXCLUDE BIBLIOGRAPHY	ON	EXCLUDE MATCHES	< 11 WORDS