Spatial Analysis of Covid-19 Distribution: case studies in Indonesia and Malaysia

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Abstract. Covid-19 has had an effect on various aspects of life. This study was to compare spatial distribution of covid-19 in Indonesia and Malaysia and its prevention efforts. The design of this study is a comparative study using descriptive analysis. Research was carry out in June through September 2020, taking location in Yogyakarta Special Region, Indonesia and Perak, Malaysia. Research focuses to data on infected positive patients with covid-19. Research data uses a secondary data, which is official statistics of covid-19. Statistical data then tabulated and mapping. The administrative map of both research sites used as a basis for the production spatial distribution map of positive patients infected with covid-19. Research shows that the number of positive patients infected by covid-19 June through September 2020 in five districts of Yogyakarta Special Region, Indonesia continued to increase significantly. Judging from time, spatial factors changes in covid-19 risk zones occurred in June to September 2020. Public movement and open access to Central Java Province causes 5 districts on Yogyakarta Special Region enter the high risk zone covid-19. Compared with Perak, Malaysia it different, spatially covid-19 infected number of positive patients in Perak, six district are relatively steady and four district are increasing. The increase occurred in Kinta District of July and August 2020, Kerian District of August 2020, Kuala Kangsar District of July 2020, and Perak Tengah District of September 2020. Judging from time, spatial factors do not changes the covid-19 risk zone from June to September 2020. Public movement and open access to Kedah, Kelantan, and Selangor caused two districts in Perak enter the high risk zone covid-19, five districts enter the medium risk zone covid-19, and three district enter the low risk zone covid-19. Indonesia and Malaysia's government efforts to prevent the spread of covid-19 are almost the same, which are restrictions on several public activities, clean and healthy socialization of living behaviour in all sectors, implementation of health discipline protocol in new normal, and provide of update covid-19 information data. The difference, lies in implementation lockdown, which some areas in Indonesia include Yogyakarta Special Region do not apply on Large Scale Social Restrictions (LSSR) like Jakarta, while a full implementation of lockdown in Malaysia through Movement Control Order (MCO) including Perak, so a growing number of covid-19 cases can be more pressure.

Keyword: Spatial distribution, Covid-19, comparative study

1. Introduction
In December 2019, reports of a virus outbreak in Wuhan, China, and spread rapidly across areas of the world, including Indonesia. The virus kills more than 800 people and infects more than 70,000 in the
first 50 days of the epidemic [12]. On February 6, 2020, the World Health Organization (WHO) officially announced the name of the virus is Corona Virus Disease 19 (covid-19), a member of the coronavirus group that can cause death. Covid-19 resembles acute respiratory syndrome such as the Severe Acute Respiratory Syndrome (SARS) outbreak in China of 2002 and the Middle-East Middle-Relief Syndrome (MERS) that first appeared in the Middle East in 2012. While covid-19, SARS, and MERS are cause by a similar strain of the virus, coronavirus, there are differences in the incubation period, the rate of contagion, and the treatment. Experts continue to study the origins of covid-19 infections [15], which are genetically classified into four major generas, Alphacoronavirus, Betacoronavirus, Gammacoronavirus, and Deltacoronavirus [9].

Covid-19 is now a strategic issue for research in all fields of science, including geography. The first reason is that the covid-19 makes major circulation in geographic space automatically stop. The covid-19 pandemic has brought financial systems to the financial crisis of national governments, European agencies, and international systems [10]. Second, because the covid-19 occupying space is spreading in more than 200 countries with the highest number of cases in the America Continent and the European Continent. Then we might conclude that the covid-19 could spread over geographic space. Geographically, climate factors show an impact on ampltude and the speed of spreading covid-19 [13]. There is also possible a factor that rests on human activity so that the covid-19 can spread.

As the number of confirmed cases covid-19 in Indonesia continues to increase, the Indonesian government designated the covid-19 epidemic as a nonnatural national disaster. The covid-19 epidemic emergency status released by the Head of the National Disaster Management Agency on January 28, 2020, and could be extend to adjust existing conditions. By providing emergency response status with covid-19 means that provincial or district governments should be ready to work 24 hours a day and expend all available resources to save their citizens from covid-19 [4]. Malaysia is not unlike Indonesia, it is also affect by covid-19 and has imposed emergency status, but the number of confirmed deaths is far below Indonesia. According to data from April 20, 2020, covid-19 deaths in Malaysia total of 89, while in Indonesia the death toll is already 590. This is possible, because Indonesia's population is greater than Malaysia.

In the face of a covid-19 patient boom, each countries apply varying efforts to the country's conditions such as geographic conditions, population size, and technological preparedness. Prevention efforts are made by both the Indonesian and Malaysia governments, including hand washing habitation, using hand sanitizer, wearing mask, social distancing, physical distancing, closing schools and campus, and quarantine of citizens in affected areas. Nevertheless, the efforts have not been able to cope with the rapid spread of the covid-19. The movement of humans from place to place because of the daily activities involved in meeting the needs of the family's life is possible as a factor so that the spread of covid-19 can be faster and less controlled.

Spatial mapping using the Geographic Information System (GIS) today is especially important in providing information about affected areas of covid-19, which this study can help to see differences in the spread of covid-19 in Indonesia and Malaysia. GIS is a manual and or computer system that is use to collect, store, manage, and produce information that has spatial or geographic references [3]. Compared with other base data systems, GIS has the advantage of presenting spatial and nonspatial information [11]. GIS component consists of hardware, software, brainware, and input. The four components that make up a system for GIS function are data input, data management, data manipulation and analysis, and output. Through the help of GIS applications, regions affected by covid-19 can easily see in a map view [1].

Since the 1960s GIS has been use to analyze, visualize and detect disease spread, even now GIS technology development can present real time data from pandemic development [2]. GIS plays a major role in visualization and tracking confirmed cases, predictions of regional transmission, spatial segmentation of risk levels and prevention. Developed a GIS based risk assessment model using three variables that is the number of cases, population migration and transport networks [16]. A model result can be a recommendation to assess areas at the highest risk level. GIS can simulate predictions of transmission of disease and infectious disease using population mobility as important parameters [14].
With a systematic analysis using GIS it is expected to help the government with covid-19 treatment. Digital maps provide a communication tool for delivering spatial distribution of covid-19 to the public and to the authorities so that efforts to prevent the spread of covid-19 in the region can be done in time.

2. Methods

The design of this study is a comparative study using descriptive analysis. The study attempts to compare spatial distribution of covid-19 in Indonesia and Malaysia and describes what communities and governments have done to prevent its spread. Research carried out from June to September 2020, taking up a research site in Yogyakarta Special Region, Indonesia and Perak, Malaysia. Yogyakarta Special Region, Indonesia consists of five district, which are Bantul District, Sleman District, Kulon Progo District, Gunungkidul District, and Yogyakarta City. Perak, Malaysia consists of 10 district, which are Kinta District, Larut and Matang District, Manjung District, Perak Hilir District, Kerian District, Batang Padang District, Kuala Kangsar District, Perak Tengah District, Hulu Perak District and Kampar District. Research are carry out in Yogyakarta Special Region, Indonesia and Perak, Malaysia with a consideration of the educational center and cultural diversity that encourage public movement into the region and accelerate the spread of covid-19.

The study focused on mapmaking that was analyzed to evaluate the objects that were mapped. The mapped object is a covid-19 positive patient at two research sites. The distribution map of infected positive patients covid-19 is a spatial model used to describe conditions in the field at the risk of the spread of covid-19 in Indonesia and Malaysia. It would represent the spatial distribution of phenomena. Geographical production of spatial models for health studies is expected to explain where, why, and what are the subjects on a region's health issue [5].

Zoning mapping activity of covid-19 spread can be made through secondary data study, which is the official statistical data of covid-19. Data is a basic and important ingredient in mapmaking because it determines the quality of the maps produced. Dickinson (1975) in [5] presents four reasons why a data is mapped, that is: (1) by map can create a greater attraction to the objects displayed, (2) by map can clarify, simplify, and explain a significant aspect, (3) by map can highlight subject points in writing or conversation, and (4) by map can be used as a source of data for the interest.

The official statistical data of covid-19 consisting collection of number then tabulated and mapping. The administrative map of both research sites is use as a basis for the production map of the spatial distribution of positive patients infected with covid-19. Spatial distribution information on positive patients infected with covid-19 according to place and time can be used to study factors related to the covid-19 pandemic and be helpful to help establish a program's priority for covid-19 prevention efforts.

3. Result and Discussions

3.1. Spatial distribution of Covid-19 in Indonesia and Malaysia

In this study to see spatial distribution of covid-19 in Indonesia and Malaysia conducted case studies for Yogyakarta Special Region, Indonesia and Perak, Malaysia. Yogyakarta Special Region is one of the 34 provinces of Indonesia. Yogyakarta Special Region bordered the Indian Ocean in the south and bordered Central Java Province in the north, east, and west. Yogyakarta Special Region has an area of 3,185.8 km² and is divide into five district. Yogyakarta Special Region for the year 2020 has 3,882,288 people and is the fourth most populating province in Indonesia. Perak is one of 14 states in Malaysia. Perak borders on Kedah in the north, Yala and Narathiwat Provinces, Thailand in the northeast, Pinang Island in the northwest, Kelantan and Pahang in the east, Selangor in the south, and the Strait of Malacca in the west. Perak has an area of 20,976 km² and is divide into 10 district. Perak population in 2020 is 2,510,300 people and is the fifth most populous state in Malaysia. Given the geographic and demographic conditions in both areas of researched it is possible that there is spatial distribution differences in positive patients infected with covid-19.
3.1.1. Spatial distribution of covid-19 in Yogyakarta Special Region, Indonesia

![Spatial distribution map of positive patients infected with covid-19 in Yogyakarta Special Region, Indonesia, June to September 2020](image)

**Figure 1.** Spatial distribution map of positive patients infected with covid-19 in Yogyakarta Special Region, Indonesia, June to September 2020 [8]

![Graph of development of positive patients infected with covid-19 in Yogyakarta Special Region, Indonesia, June to September 2020](image)

**Figure 2.** Graph of development of positive patients infected with covid-19 in Yogyakarta Special Region, Indonesia, June to September 2020 [8]

|                | June | July | August | September |
|----------------|------|------|--------|-----------|
| Bantul District| 77   | 226  | 467    | 682       |
| Sleman District| 123  | 234  | 523    | 1151      |
| Kulon Progo District| 15    | 31   | 77     | 170       |
| Gunungkidul District| 52    | 109  | 190    | 231       |
| Yogyakarta City   | 37   | 63   | 153    | 390       |
From Figure 1, based on space or spatially, Yogyakarta Special Region has five districts, it is can be seen that the number of infected patients with covid-19 continues to experience significant increase in each district. According to time, a map that has been made by reference to the number of positive patients infected with covid-19 can be categorized into high risk (red zone), medium risk (orange zone), and low risk (yellow zone). Spatially, by June 2020, Sleman District entered the covid-19 high risk zone, Bantul District and Gunungkidul District enter the medium risk zone, while the Yogyakarta City and Kulon Progo District enter the low risk zone. In July 2020, Bantul District and Gunungkidul District followed Sleman District into the covid-19 high risk zone, Yogyakarta City entered the medium risk zone, and Kulonprogo District remained in the low risk zone. In August 2020, Yogyakarta City followed Sleman District, Bantul District, and Gunungkidul District entered high risk zone, while Kulonprogo District entered the medium risk zone. In September 2020, all district of Yogyakarta Special Region enter a high risk zone of covid-19. Judging from time, spatial factor changes in covid-19 risk zones occurred in June to September 2020. Public movement cause of all district of Yogyakarta Special Region to enter the high risk zone for covid-19, this is supported by open access to the Central Java Province.

From figure 2, in June to August 2020, it is can be seen that the highest number of positive patients infected with covid-19 in Yogyakarta Special Region was in Sleman District, followed by Bantul District, Gunungkidul District, Yogyakarta City, and the lowest in Kulonprogo District. However, in September 2020, the third position was replace by Yogyakarta City and Gunungkidul District in fourth position, while others district remained in their original position. The increase in the number of infected positive patients by covid-19 in all districts in Yogyakarta Special Region certainly requires a serious effort by local government to provide intervention in covid-19 prevention efforts in the region against existing health-care systems.

Each district in policy public activity intake is expect to take into account the covid-19 risk zone category. If areas enter high risk zones, most public activities should be stopped, such as the prohibiting of meetings, closing of some business activities, and making effort people to work from home and study from home. The spread rate of the virus is out of control in this zone as local transmission is happening fast and spreading widely. Divide into a medium category zone means there is a risk of transmission and potential of the virus in the direction of uncontrolled. What can be do is that the opening of limited business activities and the public are encouraged to study from home and to adopt strict health protocols when going out. For the region of a low risk zone, which means a controlled spread, despite the potential of transmission remains, so public activity may operate by applying health protocols. It is hope that a consideration of the covid-19 risk zone in policy to public activity would reduce a surge in the case. This is reinforce by the findings of [6], which suggests that the covid-19 epidemic situation in Hubei Province can be effectively controlled the basis of governmental already applied prevention. Strict quarantine has acted to prevent and control the virus.
### 3.1.2. Spatial distribution of covid-19 in Perak, Malaysia

![Spatial distribution map of positive patients infected with covid-19 in Perak, Malaysia, June to September 2020](image)

**Figure 3.** Spatial distribution map of positive patients infected with covid-19 in Perak, Malaysia, June to September 2020 [8]

| District              | June | July | August | September |
|-----------------------|------|------|--------|-----------|
| Kinta District        | 97   | 100  | 104    | 104       |
| Larut and Matang District | 19  | 19   | 19     | 19        |
| Manjung District      | 25   | 25   | 25     | 25        |
| Perak Hilir District  | 58   | 58   | 58     | 58        |
| Kerian District       | 19   | 19   | 22     | 22        |
| Batang Padang District | 4   | 4    | 4      | 4         |
| Kuala Kangsar District | 4   | 5    | 5      | 5         |
| Perak Tengah District | 11   | 11   | 11     | 12        |
| Hulu Perak District   | 6    | 6    | 6      | 6         |
| Kampar District       | 2    | 2    | 2      | 2         |

**Table:**

| District              | Positive Patients Infected with Covid-19 |
|-----------------------|-----------------------------------------|
| Kinta District        | 97                                      |
| Larut and Matang District | 19                             |
| Manjung District      | 25                                      |
| Perak Hilir District  | 58                                      |
| Kerian District       | 19                                      |
| Batang Padang District | 4                                   |
| Kuala Kangsar District | 4                                   |
| Perak Tengah District | 11                                     |
| Hulu Perak District   | 6                                       |
| Kampar District       | 2                                       |

**Figure 4.** Graph of development of positive patients infected with covid-19 in Perak, Malaysia, June to September 2020 [8]
From figure 3, spatially Perak consist of 10 districts, it is can be seen that the number of positive patients infected with covid-19 some are relatively steady and some are increasing. The number of positive patients infected with covid-19 is relatively steady in 6 district in Perak, which are Larut and Matang District, Manjung District, Perak Hilir District, Batang Padang District, Hulu Perak District, and Kampar District, while the increase in the number of infected patients with covid-19 occurs in 4 districts, which are Kinta District, Kerian District, Kuala Kangsar District, and Perak Tengah District, although the increase in the number of infected patients is less significant. Public movement dominates the number of infected positive patients in Perak, supported by openness of access to the Kedah, Kelantan, and Selangor. Judging from time, spatial factors do not change the covid-19 risk zone from June to September 2020. Kinta District and Perak District both enter high risk zones; Batang Padang District, Hulu Perak District, Kampar District, Kuala Kangsar District, Perak Tengah District enters a medium risk zone; Larut and Matang District, Manjung District, Kerian District entered a low risk zone. The spatial analysis was helpful in understanding the spread of covid-19 in Perak, Malaysia. This is reinforce by the findings of [7] which suggests that spatial analysis is helpful in understanding the spread of infectious diseases, and spatial associations are key to spatial diffusion during the early stage of the covid-19 pandemic in China.

From figure 4, it is seen the increase in the number of infected positive patients in Kinta District in July and August 2020, Kerian District in August 2020, Kuala Kangsar District in July 2020, and Perak Tengah District in September 2020. Although the increase in the number of positive patients infected covid-19 in Perak is not as much in Yogyakarta Special Region, Indonesia, but the Malaysian government still has strict regulations to prevent local transmission quickly and widely spread, the one with lockdown policies. Some residents in Malaysia were arrest for conducting activities with large crowds, engaging in party arrangements, not wearing masks, not giving records to facilities, and violations because businesses operated outside the authorized hours.

According to data for development of covid-19 infections in Yogyakarta Special Region, Indonesia and Perak, Malaysia can be seen with the first case of positive people infected covid-19 in Perak on April 19, 2020, whereas Yogyakarta Special Region on March 15, 2020. The number of positive patients infected with covid-19 in Yogyakarta Special Region are 313 people (as of June 2020), 674 people (as of July 2020), 1,425 people (as of August 2020), 2,643 people (as of September 2020), while in Perak are 258 people (as of June 2020), 262 people (as of July 2020), 269 people (as of August 2020), 271 (as of September 2020). By dividing the number of infected covid-19 patients with the number of infected days since the first case [7], it is possible to report covid-19 infection rates in Yogyakarta Special Region, Indonesia and Perak, Malaysia in June through September, 2020 (Figure 5).

Figure 5. Graph of infection ratio of covid-19 transmission in Yogyakarta Special Region, Indonesia and Perak, Malaysia in June-September 2020 [8]
From Figure 5, it can be seen that the infectious ratio of covid-19 in Yogyakarta Special Region, Indonesia from June through September 2020 continues to increase. The increase in the ratio of Covid-19 transmission in July 2020 by 66.6%, August 2020 by 72.7%, and September 2020 by 57.5%. It is can be concluded that in Yogyakarta Special Region during June to September 2020, there has been an increase in covid-19 transmission rate. This condition are different than in Perak, Malaysia, where covid-19 infection rates from June to September 2020 tend to decline. A decrease in covid-19 infection ratio in July 2020 by 29.1 percent, August 2020 by 20.9%, and by September 2020 by 17.9%. It is possible because lockdown policies in all of Malaysia, so the Perak is particularly effective in suppressing covid-19 case spread, in contrast Yogyakarta Special Region that does not implement a Large Scale Social Restrictions (LSSR) with some consideration so that the covid-19 case spread is significantly significant.

To make clear the conditions associated with covid-19 infections in Yogyakarta Special Region, Indonesia and Perak, Malaysia, the following is the data with a percentage of people infected by covid-19 in June through September 2020 (Figure 6). Percentage of people infected by covid-19 can be calculate by dividing the number of infected covid-19 patients with the total population [7]. The total population in Indonesia in 2020 was 3,882,288 people, while in Malaysia it was 2,510,300 people.

![Figure 6](image)

**Figure 6.** Percentage of population infected with covid-19 in Yogyakarta Special Region, Indonesia and Perak, Malaysia in June-September 2020 [8]

From figure 6 it is seen that the percentage of the population infected with covid-19 in Yogyakarta Special Region, Indonesia from June through September 2020 continues to increase. Increase in percentage of infected population covid-19 in July 2020 by 100.0%, August 2020 by 100.0%, and September 2020 by 75%. Different conditions occur in Perak, Malaysia, where the percentage of infected covid-19 is relatively constant. It shows setting off lockdown for all parts of the state in Malaysia, by prohibiting people out of doors unless there is urgent interest or some emergency, including in the Perak it is very effective to suppress covid-19 surmount in Malaysia, it is different from Yogyakarta Special Region for not applying the LSSR application with several considerations.

3.2. Efforts to Prevent the Spread of Covid-19 in Indonesia and in Malaysia

Similar efforts are made by the Indonesian and Malaysia governments on the prevention of the spread of covid-19, which are (1) restrictions on some public activities, such as the implementation of some work from office (wfo) and some work from home (wfh), study from home, and business space operating restrictions, (2) clean and healthy living behaviour socialization, both for family, school, environment, workplace, and health. Socialization by (a) regularly applying hand washing with soap and running water or by hand sanitizer, (b) always keep a safe distance from others who are coughing or sneezing, (c) masks are recommended if physical restrictions are not possible, (d) forbidden to touch the eyes, nose or mouth if you do not wash your hands, (e) coughing and sneezing please cover your mouth and nose with arms or tissues, (f) staying home when not feeling well, (g) if a fever, cough, or shortness of
breath immediately seek medical attention, (h) eating foods is nutritious and balanced, (i) be diligent in exercising and sufficient rest, (3) implementation of disciplinary health protocols as key to new normal, the discipline of health protocols continues to be socialized so that people can always be productive and safe from the spread of covid-19, (4) provide information on the spread of covid-19 is updated with GIS help. GIS not only helps provide the covid-19 spread information but can be used to evaluate the quality, effectiveness, and accessibility of covid-19 treatment services for public health, such as the presence of hospitals. GIS can also provide a list of territory potential and demographic characteristics of the people, with a possible match between the number of people and existing health-care facilities.

The difference between Indonesian and Malaysian governments to prevent the spread of covid-19 follow the WHO's decision on January 30, 2020 regarding covid-19 as a global public health emergency, so with the first positive case on March 15, 2020, Yogyakarta Special Region will immediately establish the status of the covid-19 emergency response. The Government of Yogyakarta Special Region immediately works by mobilizing all available resources to save its people from the covid-19 disease, however, Yogyakarta Special Region does not carry out LSSR like Jakarta with several considerations. Unlike Yogyakarta Special Region, to prevent the spread of covid-19 where the first case occurred on April 19, 2020 in Perak, so Perak Government imposed a lockdown. In this case, there are restrictions on public movement to prevent the spread of covid-19, prohibit travel out of Perak or Malaysia and to close all business activities, except public services and grocery stores that remain in operation. Full lockdown is apply to areas that fall into the covid-19 category of high-risk zones so the area is temporarily locked down and society is not allowed in or out of the region. During a lockdown, all basic needs are guarantee by the kingdom. This is also applies to students living in campus dorms, both local and international students. Movement Control Order (MCO) became Malaysia’s main weapon against covid-19. In this case the MCO is supported with a clear legal basis, if public offense is punishable by 6 months imprisonment or a fine of RM 1000. Police and soldiers in Malaysia deployed to guard MCO policies.

4. Conclusion and Recommendation
Based on the results and discussions, the conclusions are as follows:
1. Spatially, the number of positive patients infected with covid-19 June to September 2020 in five district in Yogyakarta Special Province, Indonesia (Sleman District, Bantul District, Gunungkidul District, Kulon progo District, Yogyakarta City) continued to increase significantly, resulting all districts entering the high risk zone covid-19. Judging from time, spatial factors changes in covid-19 risk zones occurred in June to September 2020. Public movement cause of all district of Yogyakarta Special Region to enter the high risk zone for covid-19, this is supported by open access to the Central Java Province. Compared with Perak, Malaysia it different, spatially covid-19 infected number of positive patients in Perak, six district are relatively steady which are Larut and Matang District, Manjung District, Perak Hilir District, Batang Padang District, Hulu Perak District, Kampar District while four district are increasing, which are Kinta District of July and August 2020, Kerian District of August 2020, Kuala Kangsar District of July 2020, Perak Tengah District of September 2020. Judging from time, spatial factors do not change the covid-19 risk zone from June to September 2020. Public movement and open access to Kedah, Kelantan, and Selangor causes two district in Perak which are Kinta District and Perak District enter the high risk zone covid-19, five district which are Batang Padang District, Hulu Perak District, Kampar District, Kuala Kangsar District, Perak Tengah District enter the medium risk zone covid-19, and three district which are Larut and Matang District, Manjung District, Kerian District enter the low risk zone covid-19.
2. Indonesia and Malaysia's government efforts to prevent the spread of covid-19 are almost the same, which are restrictions on several public activities, clean and healthy socialization of living behaviour in all sectors, implementation of health discipline protocol in new normal, and provide of update covid-19 information data. The difference, lies in implementation lockdown, which some areas in Indonesia include Yogyakarta Special Region do not apply on Large Scale Social Restrictions
while a full implementation of lockdown in Malaysia through Movement Control Order (MCO) including Perak, so a growing number of covid-19 cases can be more pressure. Recommendations in relation to the research findings are: a sense of crisis is needed by applying caution clean and healthy lifestyle, increasing public awareness through socialization, preparing additional health services for handling covid-19 actions, involving all elements in the region for cooperation in handling covid-19 down to the lowest government structure, paying special attention to the poor who are vulnerable to the economic impact and transmission of covid-19, provide information on the development of covid-19 by utilizing the official website and other social media, as well as providing support and appreciation for medical personnel.

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