# Coronavirus (COVID-19): Density Risk Mapping Using Population and Housing Census of Malaysia 2010

*Coronavirus (COVID-19): Pemetaan Risiko Kepadatan Menggunakan Data Banci Penduduk dan Perumahan Malaysia 2010*

NUR FAZIERA YAAKUB, Ailis Elizabeth Epa[1], DANGGAT CHABO & *TARMIJI MASRON

Centre for Spatially Integrated Digital Humanities (CSIDH),
Faculty of Social Sciences and Humanities (FSSH),
Universiti Malaysia Sarawak (UNIMAS),
Jalan Datuk Mohammad Musa,
94300 Kota Samarahan, Sarawak, Malaysia.

[1]Department of Geography, School of Humanities,
Universiti Sains Malaysia (USM),
11800, Pulau Pinang, Malaysia.

*corresponding author: mtarmiji@unimas.my

Published online: 13 November 2020
To cite this article (APA): Nur Faziera, Y., Ailis Elizabeth, E., Danggat, C., & Tarmiji, M. (2020). Coronavirus (COVID-19): Density risk mapping using Population and Housing Census of Malaysia 2010. *GEOGRAFI*, *8*(2), 21-47. https://doi.org/10.37134/geografi.vol8.2.2.2020

To link to this article: https://doi.org/10.37134/geografi.vol8.2.2.2020

**ABSTRACT** *The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that caused the Coronavirus Disease 2019 (COVID-19) is a newly discovered severe and contagious disease. Due to its seriousness, the rapid spread of the virus has awakened worldwide attention in a short time. Due to the scarcity of effective treatment options for the rising positive cases worldwide, the risk of COVID-19 is observed serious for the infected persons with chronic diseases as well as vulnerable populations including infants and aging groups. By applying the spatial-based solution tool of Geographic Information Systems (GIS), this paper aims to localize the spatial distribution of cumulative COVID-19 cases and the density of different age groups of all districts for both West and East Malaysia. The non-spatial data used in this research paper were the cumulative number of COVID-19 positive cases on 25th of January, 15th of February, 21st of March, 31st of March, 14th of April & 12th of May 2020 and the total number of population in Malaysia sourced from Population and Housing Census of Malaysia 2010. The population was divided into three (3) different age groups. The three (3) age groups indicate the level of population density of a district. While the spatial data were district boundaries across Malaysia. The results geovisualized that big cities with a high density of population such as the Federal Territory of Kuala Lumpur, Petaling, Johor Bahru, Kuching, Miri, Sibu and Kota Kinabalu experienced a high number of COVID-19 positive cases.*

**Keywords:** Aging population, population density, different age groups, census, COVID-19, Geographic Information Systems (GIS) & risk mapping

*Geografi Vol.8(2), 21-47*
*ISSN 2289-4470 /eISSN 2462-2400*

**ABSTRAK** *Koronavirus sindrom pernafasan akut teruk 2 (SARS-CoV-2) menjadi menyebabkan Penyakit Coronavirus 2019 (COVID-19) merupakan penyakit kronik berjangkit yang baharu ditemui. Oleh kerana tahap penyebaran virus ini dilihat agak membimbangkan, maka ia telah menarik perhatian seluruh dunia dalam waktu yang singkat. Di samping mengalami kesulitan daripada segi rawatan yang berkesan untuk merawat bilangan pesakit yang semakin meningkat, populasi dunia juga mengalami kebimbangan yang tinggi kerana COVID-19 ini dilihat cenderung untuk menjangkiti mereka yang mempunyai penyakit kronik serta golongan kanak-kanak dan warga tua. Dengan menggunakan medium penyelesaian berasaskan reruang Sistem Maklumat Geografi (GIS), artikel ini bertujuan untuk memetakan taburan reruang kes kumulatif COVID-19 dan kepadatan kumpulan umur yang berbeza di semua daerah Malaysia. Data bukan reruang yang digunakan dalam penyelidikan ini adalah jumlah terkumpul kes positif COVID-19 pada 25 Januari, 15 Februari, 21 Mac, 31 Mac, 14 April & 12 Mei 2020 dan jumlah keseluruhan penduduk di Malaysia yang bersumber daripada Banci Penduduk dan Perumahan Malaysia 2010. Penduduk dibahagikan kepada tiga (3) kumpulan umur yang berbeza dan ketiga-tiga kumpulan umur tersebut digunakan untuk menunjukkan tahap kepadatan penduduk di sesebuah daerah. Manakala data reraung yang digunakan adalah sempadan daerah di seluruh Malaysia. Hasil geovisualisasi bahawa bandar-bandar besar dengan kepadatan penduduk yang tinggi seperti Wilayah Persekutuan Kuala Lumpur, Petaling, Johor Bahru, Kuching, Miri, Sibu dan Kota Kinabalu mengalami peningkatan kes kumulatif positif COVID-19 yang ketara.*

**Kata Kunci:** Banci, COVID-19, kepadatan penduduk, kumpulan umur yang berbeza, penduduk menua, pemetaan risiko & Sistem Maklumat Geografi (GIS)

## 1. Introduction

Coronaviruses are a group of viruses, which belong to the family of *Coronaviridae*, and have the capability to infect both humans and animals (World Health Organization, 2020a; Gennaro *et al*., 2020; Unhale *et al*., 2020). Currently, a novel coronavirus, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has caused the Coronavirus Disease 2019 (COVID-19) (Dhama *et al*., 2020; Maxwell *et al.,* 2020; Boulos & Geraghty, 2020). Tracing back the medical records, the first human case of COVID-19 was reported by official in Wuhan City, Hubei Province, China on 17$^{th}$ of December 2019 (Maxwell *et al.,* 2020; Hackoum & Abdallah, 2020; Kang *et al.,* 2020; Boulos & Geragthy, 2020). Medically supported by retrospective research, the Chinese authorities started identifying the symptomatic human cases in early December 2019 (World Health Organization, 2020b). Beyond human controls, the Novel Coronavirus (COVID-19) outbreak at the end of 2019 has led to an unforeseen global plague. Despite China's immense efforts to contain the virus within Hubei, it has spread so rapidly and widely to the other parts of China and other countries around the world are battling against the deadly virus too. Statistically sourced by European Centre for Disease Prevention and Control (2020), as of 8$^{th}$ of August 2020, the five (5) countries that reported the most cumulative positive cases in Asia were India (2,088,611), Iran (322,567), Saudi Arabia (285,793), Pakistan (283,487) and Bangladesh (252,502). The high number of COVID-19 outbreaks is proving to be an unprecedented disaster

particularly in health, social and economic (Gennaro *et al*., 2020). People worldwide are now practicing and living a new norm as to cope with the daunting pandemic.

## 2. Literature Review

Geographic Information Systems (GIS) is a computer system with the capacity to capture, store, analyze and display spatial-based data and geographically-referenced information (Tarmiji *et al.,* 2018 and Musa *et al.,* 2013). Its multi-function operations have caught the attention of both the public and private sectors. Since then, the integration of GIS with various fields and disciplines such as agriculture, forestry and geology has been recognized internationally in producing more focus and precise analysis as it introduces spatial elements (Singh *et al.,* 2016). Besides, many publications in Malaysia have also confirmed that GIS has been applied widely. For instance, in criminology (Jubit *et al.,* 2020; Mohd Norarshad and Tarmiji, 2016) as well as public health (Busiai and Tarmiji, 2019). Coping parallel with the current public health and the pandemic issue, Environmental Systems Research Institute (ESRI) (2020) supports the fact that location information is important for decision-making that involves large-outbreak. "When disease can travel so quickly, information has to move even faster" (Boulos and Geraghty, 2020, p. 2). Moreover, based on McLafferty (2003), people are not evenly distributed across the Earth's surface, and populations differ along many dimensions including age, gender, culture, and economic status. Hence, people need to react and plan quicker in order to combat the spreading of diseases. In conjunction with the strong framework for answering many infectious disease-related problems, this research integrates GIS with demography and health, specifically concentrating on the Malaysian population and epidemiology. Full attention is given to these fields due to the pandemic COVID-19 cases that transpire globally, including Malaysia.

In Malaysia, as of 8th of August 2020, the number of cumulative cases has reached 9,070. From the total number, 8,775 patients (96.8%) have been discharged, leaving 170 active cases under medical surveillance. As of the mentioned date, Malaysia recorded 125 deaths (1.38%) with the majority of the age between 61 to 70 years old, followed by the age group between 71 to 80 years old (Kementerian Kesihatan Malaysia, 2020).From the medical GIS's point of view, Fatemah and Leila (2017) conducted a research on maternal health in Kerman, Iran. The authors applied the Analytic Hierarchy Process (AHP) and test-retest methods before mapping the results by using GIS software. The results found that the majority of mothers in Kerman have a modest level of access to maternal care amenities. Historically, Snow (1855) traced the source of the Cholera outbreak in Soho, London. It was done by using manual spatial analysis of hand-drawn paper maps that relate the cholera cases with the water pumps and water supply. Adapting GIS with the current pandemic issue, Suleman *et al.* (2020) illustrated a graphical abstract that explains the process of tracing the number of COVID-19 cases is done by locating the areas with a high number of COVID-19 cases followed by implementing appropriate actions at the high-risk areas

*Geografi Vol.8(2), 21-47*
*ISSN 2289-4470 /eISSN 2462-2400*

by the authorities. The authors geo-visualized the COVID-19 outbreak in Pakistan and stated that the application of GIS provides significant advantages. It includes access to a large number of spatial functions and big data. On the other hand, Chen *et al.* (2020) applied a Bayesian spatial-temporal model to locate the distribution of COVID-19 cases and their correlation with the migration of the Wuhan population in the early stages of the pandemic. The action showed pronounced importance for early warning and prevention of future outbreaks. Whereas, Tang *et al.* (2020) tried Poisson's segmented model to arrange for further explanations for the changing patterns in the different geographical areas of China. While Zhang *et al.* (2020) attempted to determine either the pattern of spatial-temporal behavior of COVID-19 is related to SARS 2003 or vice versa. They then ended up with negative results owing to changes in social factors, local government control strategies as well as differences in the dynamics of transmission between these two (2) strains of coronaviruses.

In the USA, Jella *et al.* (2020) acknowledged the spatial distribution of age-group that are considered more risky and vulnerable to the COVID-19. In their research, orthopedic surgeons aged 65 years and more were chosen to compare their geographic distribution with those patients diagnosed with COVID-19. The main objective of the research was to conclude the potential risk of orthopedic surgeons compared to other groups. The results found that the highest cases occurred in the states that were most highly affected by COVID-19. Listed were New York, New Jersey, California and Florida. From the economic point of view, Minetto *et al.* (2020) measured changes in economic activity since movement control measures were adopted in Munich, Phoenix, Moscow, Wuhan, North Korea. They used the previous and current COVID-19 satellite images in order to identify the changes in vehicle volume at regular points of road geometries, ship stream of traffic at anchorages as well as airplanes at entrances.

COVID-19 pandemic is capable of infecting all age groups. The youngest patient was reported to be a 30-hour new born and the oldest patient recorded was a 104-year-old. Large-scale analysis conducted by the Centers for Disease Control and Prevention in China shows that all age groups are prone to COVID-19 infection. In Malaysia, statistics show that the two (2) age groups of the community with the highest COVID-19 positive cases are in the range of 26 to 30-year-old and 56 to 60-year-old (Bernama, 2020). Even so, the prevalence of each age group varies among the different countries.

## 3. Methodology

This research study required both spatial and aspatial data. Spatial data included the district boundaries across all states and federal territories in Malaysia. The unit of analysis used was at the district level. As districts' boundaries in Malaysia do change over space and time, georeferencing and digitization were conducted precisely in order to keep up with the number of districts in Malaysia for the year 2010. Generated from both processes, the total number of districts in Malaysia used in this research

study were 145. While aspatial data encompassed the cumulative number of COVID-19 cases on 25th of January, 15th of February, 21st of March, 31st of March, 14th of April and 12th of May 2020 as well as the total number of population in Malaysia based on the Population and Housing Census of Malaysia 2010. The total population was divided into three (3) different groups based on their ages namely school-age of 10 to 19-year-old, productive age of 20 to 59-year-old and elderly population 60-year-old and above. The Malaysian population data used in the study was obtained from the Population and Housing Census of Malaysia 2010 that officially and reliably released by the Department of Statistics Malaysia (DoSM).

## 4. Analysis and Discussion

As the definition of population density of a country is the number of people in that country divided by the area in square kilometers or miles, therefore, this research attempts to look at the correlation between the spatial distribution of the Malaysian population by different age groups with the number of COVID-19 cases. According to Tarmiji *et al.* (2019), people are competing to secure places in big cities as the city acts as central to all forms of economic activity, administrative, political, cultural, education, research and innovation. Based on a theory proposed by Hamidi *et al.* (2020), dense areas lead to more face-to-face interaction among residents, which makes them potential hotspots for the rapid spread of pandemics. A monograph prepared by Tarmiji *et al.* (2020) pointed out that continuous physical contact has intensified in transmitting the virus. This is because the modes of COVID-19 transmission are through droplets. For example, poor ethics of sneezing, touching and coughing among people has worsened the transmitting of COVID-19. In this research paper, major attention is given to the density level of different age groups where they act as the basis for understanding the risk of infection of COVID-19.

### 4.1 As of 25th of January 2020

In Malaysia, the first case was detected on 25th of January 2020 (Kenyataan Akhbar, 25 January 2020). Hand in glove, the first death due to the SARS-CoV-2 infection was reported on the 17th March 2020 (Kenyataan Akhbar, 17 March 2020). There were already eight (8) cases reported by the end of the week since the first case in Malaysia (Kenyataan Akhbar, 1 February 2020). As of 25th of January 2020 in Peninsular Malaysia, the cumulative number of COVID-19 in Petaling and Johor Bharu were three (3) and one (1) cases respectively. There were no positive cases of COVID-19 detected in Sabah and Sarawak back at that time. Map 1 shows the spatial distribution of the school-age population in Peninsular Malaysia. Petaling had a school-age population of 277,503. Johor Bahru, on the other hand, had a school-age population of 241,686. Next, the number of the school-age population in the Federal Territory of Kuala Lumpur was 241,080. In Sabah and Sarawak, the highest number of the school-age population was located in Kota Kinabalu and Kuching with 88,572 and 104,346

*Geografi Vol.8(2), 21-47*
*ISSN 2289-4470 /eISSN 2462-2400*

number of students respectively. Map 2 shows the spatial distribution of the productive population in Peninsular Malaysia. Petaling had a productive population of 1,248,559 while the number of productive population in the Federal Territory of Kuala Lumpur was 10,830,390. Johor Bahru with 171,261 productive people. In Sabah and Sarawak, there were 385,077 productive people in Kuching, followed by Kota Kinabalu with 318,563 productive people, Sandakan with 286,378 productive people, Tawau with 270,785 productive people, and Miri with 200,071 productive people.

Map 3 shows the spatial distribution of the aging population in Peninsular Malaysia. The highest aging population was located in Kuala Lumpur with 264,580 followed by Petaling with 239,433. Next, the number of the aging population in Kinta was recorded at 176,005. In Sabah and Sarawak, the number of the aging population in Kota Kinabalu was 44,923, Sandakan 39,967, Tawau 38,652, Kuching 109,194, Miri 40,363 and Sibu 40,123 respectively.

**4.2 As of 15th of February 2020**

On 8th of February 2020, the number of cases had doubled to 16 cases (Kenyataan Akhbar, 9 February 2020). By the subsequent week, the number of cases had escalated to 22 (Kenyataan Akhbar, 15 February 2020). There were no new cases reported for 11 days until on 27th of February 2020. On 15th of February 2020, Petaling recorded 8 new cases, Kuala Lumpur with 4 new cases, Johor Bahru with 4 new cases, Seremban with 2 new cases, Kota Setar with 2 new cases, and Langkawi with 2 cases. Map 4 shows the spatial distribution of the school-age population in Peninsular Malaysia. The most productive population was found high in the Petaling with a total population of a school-age 277,502. Followed by Petaling and Kuala Lumpur with a total of a school-age population of 241,686 and 241,080 respectively. In Sabah, the largest school-age population was located in Kota Kinabalu with 88,572 students. In Tawau, a school-age population of 88,236 was recorded while in Sandakan the number was recorded at 69,945. In Sarawak, the school-age population in Kuching was 104,346 followed by 49,840 in Miri, 40,123 in Sibu, and 34,601 in Bintulu. Map 5 shows the spatial distribution of the productive population in Peninsular Malaysia. Petaling was ranked as the district with the most populous productive population with 1,248,559 people. In Sabah, the highest number of productive population was in Kota Kinabalu with 318,563 people while in Sarawak, the highest number of productive population was in Kuching with 385,077 people. Map 6 shows the spatial distribution of the aging population in Peninsular Malaysia. The largest aging population was recorded in Petaling with 239,433 people. Followed by the Federal Territory of Kuala Lumpur with a total aging population of 264,580 while Johor Bahru with 171,261 people. In Sarawak, the largest aging population was located in Kuching with 109,194 people. Miri, on the other hand, recorded an aging population of 40,363 people. Next, in Sabah, Kota Kinabalu recorded a total of 44,923 aging population.

### 4.5 As of 21st of March 2020

As of 21st of March 2020, there were another 153 new cases recorded. The new cases brought the cumulative number of COVID-19 patients in Malaysia to 1,183 cases. Map 7a shows the spatial distribution of the school-age population by districts in Peninsular Malaysia and the cumulative number of COVID-19 cases. The geovisualization shows that the district with the highest school-age population was Petaling with 277,503 students and 96 cumulative cases of COVID-19. This was followed by the number of the school-age population in Johor Bahru at 241,686 with 52 COVID-19 cases. Furthermore, the school-age population was also high in the Federal Territory of Kuala Lumpur with a total of 241,080 and 166 COVID-19 cases. Based on Map 7b, in Sarawak, the district with a large school population is in Kuching was found to have the highest school-age population of 104,346 with cumulative COVID-19 cases of 31 cases. In Sabah, the district with the highest school population is in Kota Kinabalu which is 88,572 with COVID-19 cases of 17 cases.

Map 8a shows the spatial distribution of the productive population in Peninsular Malaysia and the number of COVID-19 cases by districts. The geovisualization results show that the productive population was highly concentrated in Petaling with 1,248,559 people. Next, the productive population in the Federal Territory of Kuala Lumpur was also high with 1,083,090 people. Petaling and the Federal Territory of Kuala Lumpur were banded together as Red Zone as the COVID-19 cumulative cases recorded in both districts were 96 and 166 cases respectively. The immense number was because Petaling and the Federal Territory of Kuala Lumpur experienced the highest population growth among other districts. In 2000, Selangor had a total population of 4,188,876 people. Ten years later, the figure increased to 5,462,141 people with an average annual population growth rate of 2.6%. Selangor has always recorded the highest percentage of population growth rate as a result of migration into the state to seek employment opportunities, especially in the field of industry and manufacturing (Department of Statistics Malaysia, 1996). Developed areas or big cities such as Petaling and Kuala Lumpur were experiencing rapid development and those areas would be the target and medium for the population growth (Ruslan *et al*., 2006). Apart from that, the migration to the state of Selangor was also for the purpose of furthering education at both the public and the private institutions of higher learning. Map 8b shows the spatial distribution of the productive population with the cumulative number of COVID-19 cases in Sarawak, Sabah, and the Federal Territory of Labuan. In this research paper, a productive population means people who work. In Sarawak, Kuching had a high number of productive population of 385,077 with 30 recorded cases of COVID-19. In Sabah, Kota Kinabalu had a productive population of 318,563 with 17 recorded cases of COVID-19. Apart from that, a large productive population was also found in Sandakan, Tawau, and Miri with 286,378, 270,785, and 200,071 people respectively. In that order, those three districts recorded a cumulative number of cases of 8, 37 and 8 cases. Map 9a shows the spatial distribution of the aging population by districts in Peninsular

*Geografi Vol.8(2), 21-47*
*ISSN 2289-4470 /eISSN 2462-2400*

Malaysia and the COVID-19 cases. The Federal Territory of Kuala Lumpur recorded the highest aging population of 264,580 people with cumulative COVID-19 cases of 166, while Petaling recorded 239,433 aging populations and 96 cumulative cases of COVID-19. Next, the number of the aging population in Kinta was 176,005 and the COVID-19 cumulative cases were 21. Subsequently, Johor Bahru had an aging population of 171,261 people with a cumulative number of 52 COVID-19 cases. Besides, the highest aging population was also found in other districts such as Hulu Langat, Timur Laut, and Klang with 148,992, 125,445, and 115,503 people respectively. Correspondingly, those districts recorded cumulative cases of 75, 27, and 23 cases respectively. The districts that were classified as the Red Zone (Area of more than 41 cases) were Kuala Lumpur, Petaling, Johor Bahru, and Hulu Langat. While the Northeast, Kinta, and Klang were labeled as the Yellow Zone (Area of between 1 to 40 cases). Map 9b shows the spatial distribution of the aging population and the cumulative cases of COVID-19 in Sarawak, Sabah, and the Federal Territory of Labuan. Kuching had the largest aging population with 10,9194 people and this was followed by Kota Kinabalu with 4,4923 people. Also, the aging population was found high in Miri with 40,363 people. These three districts recorded the cumulative cases of 30, 17 and 8 cases respectively. In Sabah, Tawau and the Federal Territory of Labuan also recorded a high number of the aging population of 3,8652 people and 9,028 people respectively. The COVID-19 cumulative cases of those two districts were 37 and 5 cases respectively.

**4.6 As of 31st of March 2020**

Map 10a shows the spatial distribution of the population aged 10 to 19 years old and the cumulative number of COVID-19 cases in Peninsular Malaysia. By the end of Phase 1 of MCO, 11 districts were classified as Red Zone at the end of Phase 1 of MCO. The geovisualization results show that the districts which were labeled as Red Zone did relate with the school-age population. The spatial pattern showed that the virus began to spread to the north of Peninsular Malaysia. For example, Kinta had a school-age population of 108,301 people with 77 positive cases. The spatial pattern was also found similar on the spatial trend of the East Coast. For instance, Kota Bahru had a school population of 85,019 people with 80 cases. Meanwhile, based on Map 10b, in Sabah and Sarawak, the school-age population was found high in Kuching and Kota Kinabalu with 104,346 and 88,572 people respectively. One-to-one, the number of COVID-19 cases were 97 and 29.Map 11a shows the spatial distribution of the productive population and the cumulative number of COVID-19 cases in Peninsular Malaysia. The analysis confirmed that the number of productive population was large in big cities such as Petaling, Kuala Lumpur, Johor Bahru, and Hulu Langat. The number of COVID-19 cases of those four districts was recorded at 234, 430, 112 and 265 cases respectively. According to Map 11b, in Sabah and Sarawak, the productive population was high in Kuching and Kota Kinabalu. Kuching had a population of 385,077 people while Kota Kinabalu had a population of 44,923 people with recorded

cases of 97 and 29 correspondingly. Map 12a shows the spatial distribution of the aging population and the cumulative number of COVID-19 cases in Peninsular Malaysia. The district with the highest number of population was the Federal Territory of Kuala Lumpur with 264,580 people and 430 COVID-19 cases. The second district with the highest population was Petaling with 239,433 people and 234 cases records. Next, Kinta was ranked as the third district with the highest aging population of 176,005 people and 77 positive cases of COVID-19. Based on Map 12b, in Sarawak, the district with the largest aging population was Kuching with 109,194 people and 97 COVID-19 cases. While in Sabah, Kota Kinabalu had a population of 44,923 people and 29 recorded cases.

**4.7 As of 14th of April 2020**

As of 14th of April 2020, the cumulative cases of COVID-19 were recorded at 4,987 cases. To that date, 22 districts were classified as Red Zone in Peninsular Malaysia. Map 13a shows the spatial distribution of the school-age population and the cumulative cases of COVID-19 in Peninsular Malaysia. The geovisualization results show that the school-age population was found large in the Red Zone area. Among the districts with the large school-age population was Petaling with 277,503 people, followed by Johor Bahru with 241,686 people, and Kuala Lumpur with 241,080 people. The number of COVID-19 cases for those districts was 359, 184, and 899 respectively. Map 13b shows the spatial distribution for East Malaysia. In Sarawak, Kuching and Samarahan were Red Zone with 240 and 51 recorded cases respectively. In Sabah, Tawau was also a Red Zone with 79 recorded cases. For the spatial distribution of people, Kuching recorded the largest number of the school-age population of 104,346 people followed by Kota Kinabalu with 88,572 people and Tawau with 88,236 people.

Map 14a shows the spatial distribution of the productive population and the cumulative cases of COVID-19 in Peninsular Malaysia. The geovisualization shows that the most productive population distribution was located in Petaling with 1,248,559 people and 359 recorded cases. The second district with the most productive population was the Federal Territory of Kuala Lumpur with 1,083,090 people and the number of COVID-19 cases was 899 cases. The third district with the most productive population was Johor Bahru with 921,241 people with 112 cases. Map 14b shows the spatial distribution of the productive population and the cumulative cases of COVID-19 in East Malaysia. In Sabah and Sarawak, the productive population was found high in Kota Kinabalu and Kuching. While the number of COVID-19 cumulative cases for those two districts was 40 and 240 cases respectively.

Map 15a shows the spatial distribution of the aging population with the cumulative case of COVID-19 in Peninsular Malaysia. The district with the highest aging population was the Federal Territory of Kuala Lumpur with 264,580 people and a total of 899 cases. This was followed by Petaling with 239,433 aging population and 359 recorded cases. Next, Kinta had an aging population of 176,005 people and 93 COVID-19 cases. While Map 15b shows the spatial distribution of the aging population with the cumulative case of COVID-19 in East Malaysia. In Sabah, the

*Geografi Vol.8(2), 21-47*
*ISSN 2289-4470 /eISSN 2462-2400*

highest number of aging population was traced in Kota Kinabalu with 44,923 people and 40 cases of COVID-19. While the highest aging population in Sarawak was found in Kuching with 109,194 people and 240 recorded cases.

### 4.8 As of 28th of April 2020

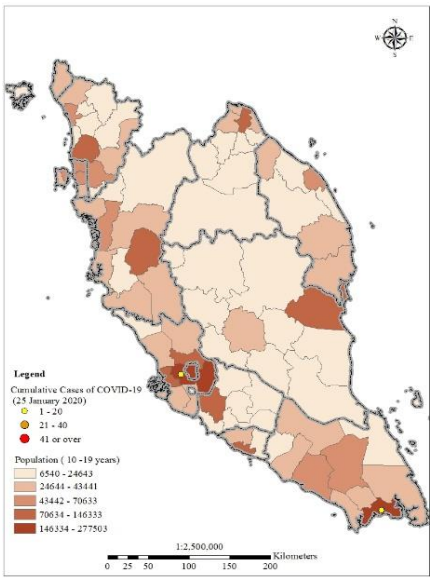
Map 16a shows the spatial distribution of the school-age population in Peninsular Malaysia and the number of positive cases of COVID-19. The district with the largest population was Petaling with 277,403 with 376 recorded cases. Followed by Johor Bahru with 241,686 people and 167 recorded cases. Next, the Federal Territory of Kuala Lumpur had a school-age population of 241,080 people and 1,214 recorded cases. Map 16b shows the spatial distribution of the school-age population in East Malaysia. In Sabah and Sarawak, the districts with the largest school-age population were in Kota Kinabalu and Kuching. The school-age population in those two districts was 88,572 and 104,346 with 48 and 305 recorded cases respectively.

Map 17a shows the spatial distribution of the productive population and COVID-19 cumulative cases in Peninsular Malaysia. Petaling had the highest number of productive population of 1,248,559 and 376 positive cumulative cases. Also, the Federal Territory of Kuala Lumpur had a high number of productive population of 1,083,090 with 1,214 positive cumulative cases. Map 17b shows the spatial distribution of the productive population and COVID-19 cumulative cases in Sabah and Sarawak. In Sabah, Kota Kinabalu ranked at the first place of having the highest number of productive population with 318,563 people and the cumulative number of COVID-19 of 48 cases. Besides, Sandakan had a high number of productive population of 286,378 people and 21 COVID-19 cumulative cases. While Tawau had a productive population of 270,785 people and 81 COVID-19 cumulative cases. In Sarawak, Kuching had the highest number of productive population of 385,077 and 305 COVID-19 cumulative cases. Besides Kuching, Miri also had a high number of productive population of 200,071 people and 23 COVID-19 cumulative cases. While Sibu had a productive population of 156,597 people and 5 cumulative COVID-19 cumulative cases. Map 18a shows the spatial distribution of the aging population in Peninsular Malaysia with the cumulative number of COVID-19 cases. The district with the largest population was the Federal Territory of Kuala Lumpur with 264,580 people and 1,214 positive cases of COVID-19. Map 18b shows the spatial distribution of the aging population in East Malaysia. In Sabah, the majority of the aging population lived in Kota Kinabalu, Sandakan, and Tawau. The aging population in Kota Kinabalu was 44,923 people with 48 cumulative cases.

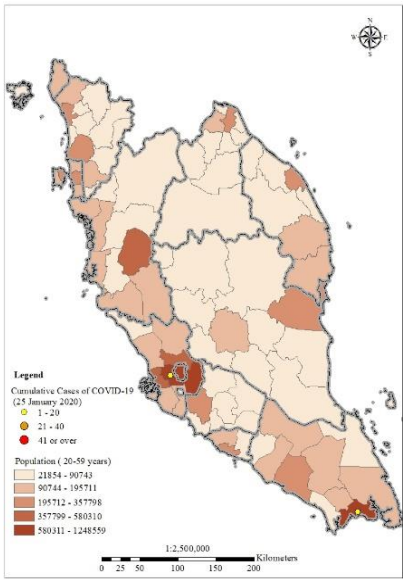
### 4.9 As of 12th May 2020

As of 12th of May 2020, the cumulative number of positive COVID-19 in Malaysia was 6,742 cases. In Peninsular Malaysia, 23 districts were classified as Red Zone. Among the districts were Hulu Langat, Federal Territory of Kuala Lumpur, and Petaling 415 with a number of cases of 500, 1,470 and 415 cases respectively. Meanwhile, there were

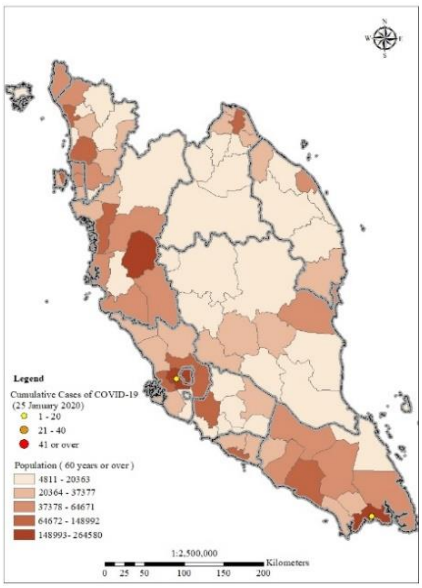
5 districts recorded more than 40 cases in Sabah and Sarawak. Namely was Kuching with 328 cases, Samarahan with 96 cases, Tawau with 83 cases, Kota Kinabalu with 51 cases, and Lahad Datu with 47 cases. Map 19a shows the spatial distribution of the school-age population in Peninsular Malaysia and Map 19b shows the spatial distribution of the school-age population in Sabah and Sarawak. Based on the map, the majority of the school-age population was found in Petaling, Johor Bahru, the Federal Territory of Kuala Lumpur, and Hulu Langat. Petaling had a school population of 277,503. In Sabah and Sarawak, the school population was viewed largely in Kota Kinabalu, Tawau, Sandakan, Kuching, and Miri. Map 20a shows the productive population in Peninsular Malaysia while Map 20b shows the productive population in Sabah and Sarawak. The geovisualization shows that the area with the most productive population was Petaling with 1,248,559 people. Followed by the Federal Territory of Kuala Lumpur with a productive population of 1,083,090. Next was Johor Bahru with a productive population of 921,241 people. In Sarawak, the productive population was large in Kuching with 385,077 people. While in Sabah, the productive population was found high in Kota Kinabalu with 318,563. Map 21a shows the spatial distribution of the aging population in Peninsular Malaysia with the cumulative number of COVID-19 cases while Map 21b shows the spatial distribution of the aging population in Sabah and Sarawak with the cumulative number of COVID-19 cases. The results show that the district with the largest aging population was the Federal Territory of Kuala Lumpur with a total of 264,580 people and 1,470 positive cases. Meanwhile in Sabah, the aging population was highly concentrated in Kota Kinabalu with 44,923 people and 51 positive cases. In Sarawak, the aging population was highly found in Kuching with a total of 109,194 people.




Map 1: Spatial Distribution of the School-age Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 25th of January 2020

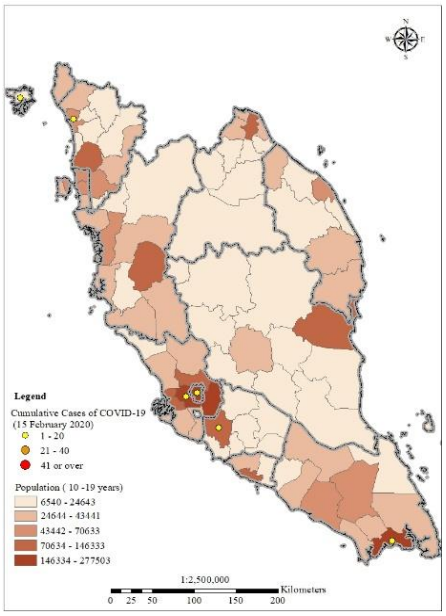



Map 2: Spatial Distribution of the Productive Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 25th of January 2020

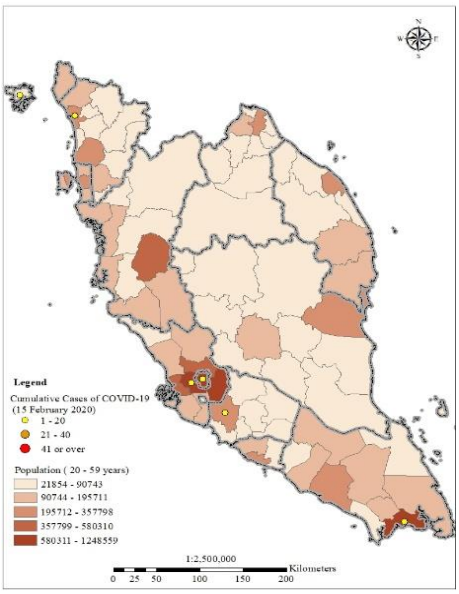



Map 3: Spatial Distribution of the Aging Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 25th of January 2020

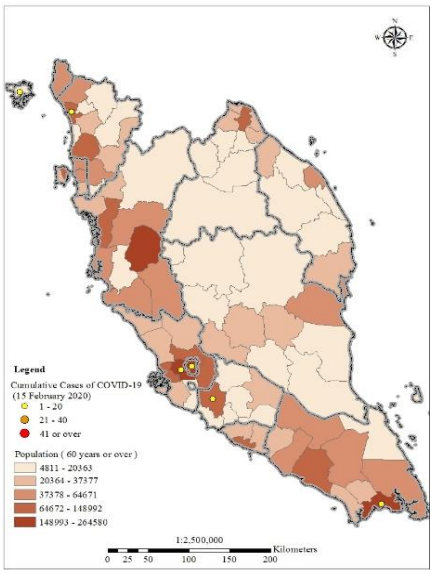
*Geografi Vol.8(2), 21-47*
*ISSN 2289-4470 /eISSN 2462-2400*



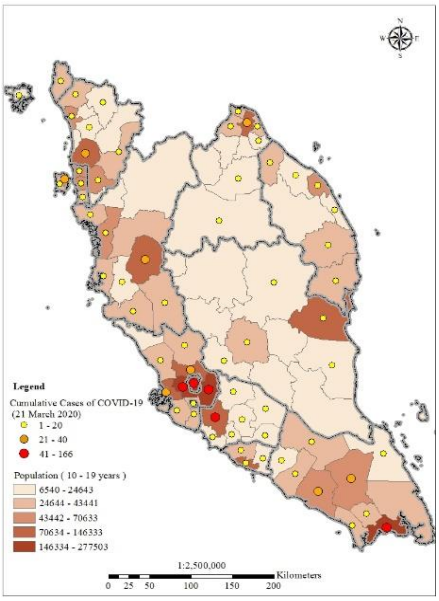

Map 4: Spatial Distribution of the School-age Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 15th of February 2020



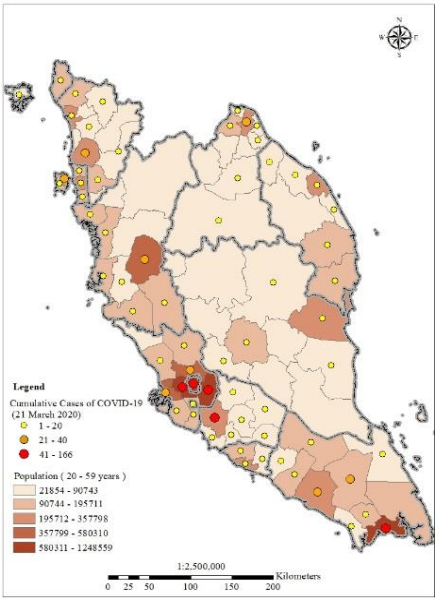

Map 5: Spatial Distribution of the Productive Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 15th of February 2020



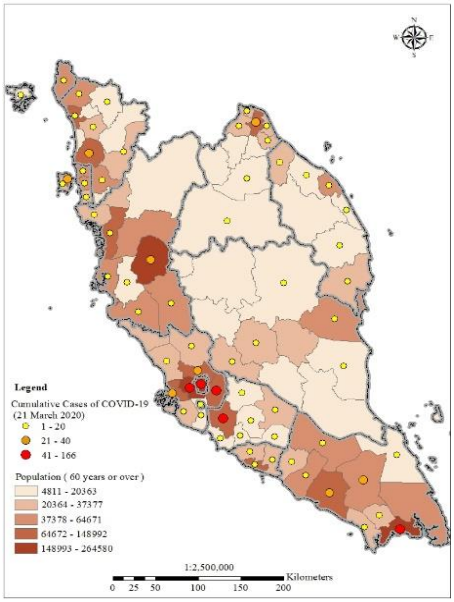

Map 6: Spatial Distribution of the Aging Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 15th of February 2020



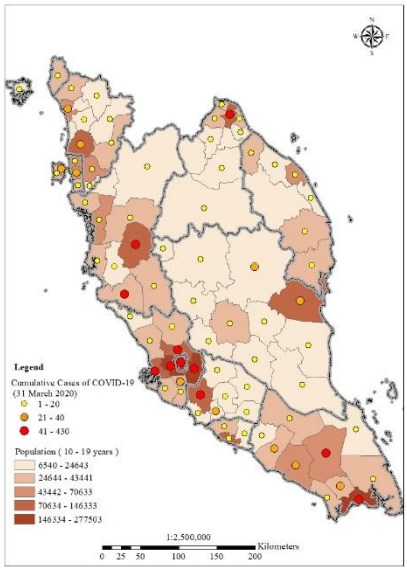

Map 7a: Spatial Distribution of the School-age Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 21st of March 2020



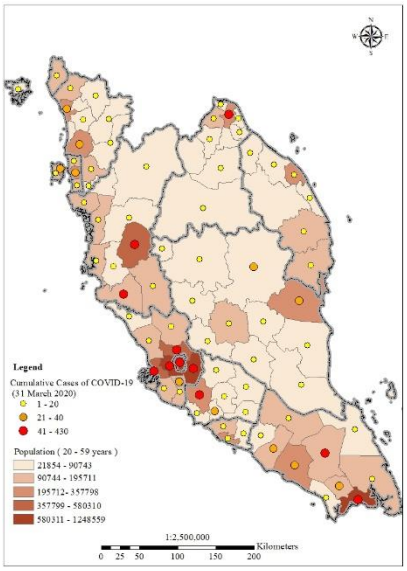

Map 8a: Spatial Distribution of the Productive Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 21th of March 2020



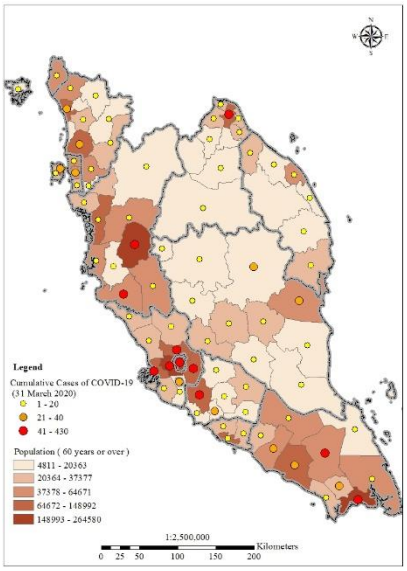

Map 9a: Spatial Distribution of the Aging Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 21th of



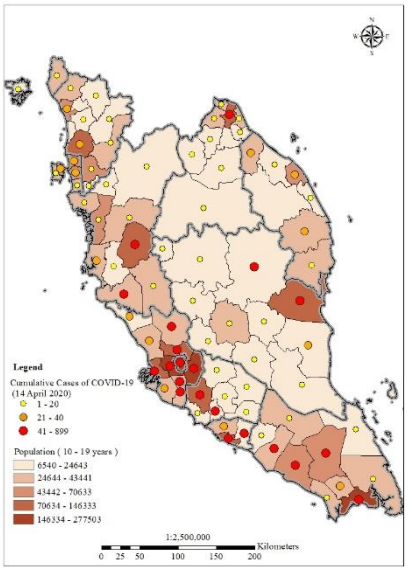

Map 10a: Spatial Distribution of the School-age Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 31st of March 2020



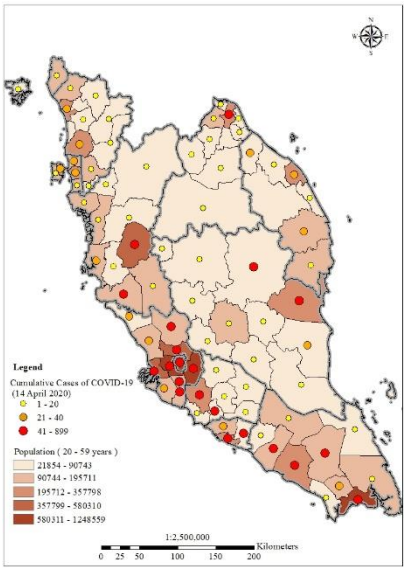

Map 11a: Spatial Distribution of the Productive Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 31th of March 2020



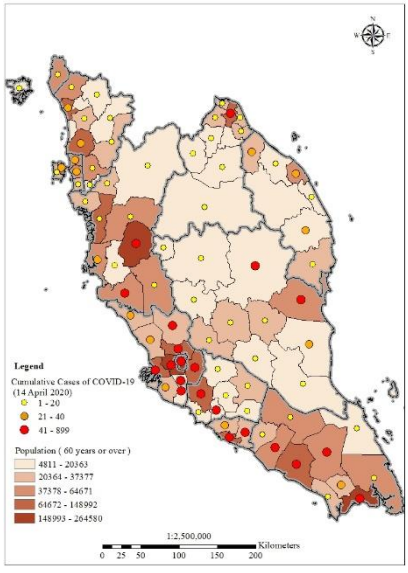

Map 12a: Spatial Distribution of the Aging Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 31th of March 2020




Map 13a: Spatial Distribution of the School-age Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 14th of April 2020

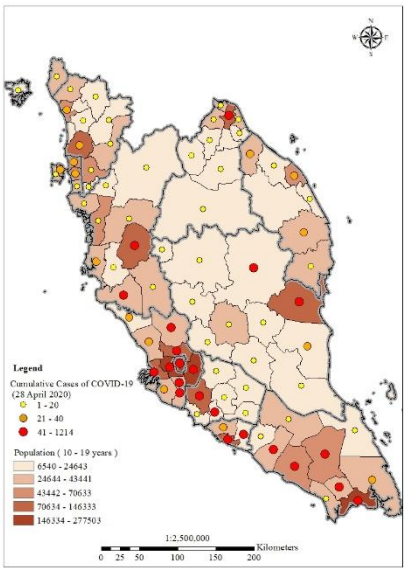



Map 14a: Spatial Distribution of the Productive Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 14th of April 2020

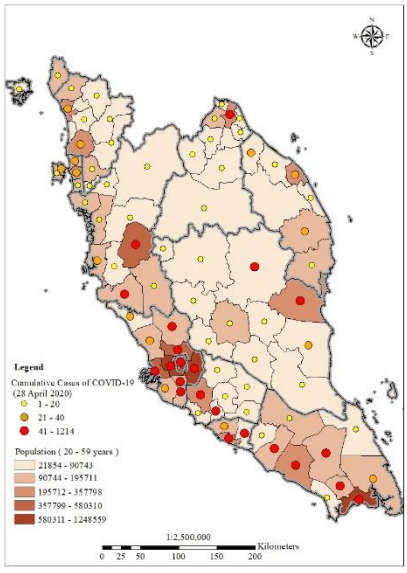



Map 15a: Spatial Distribution of the Aging Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 14th of April 2020

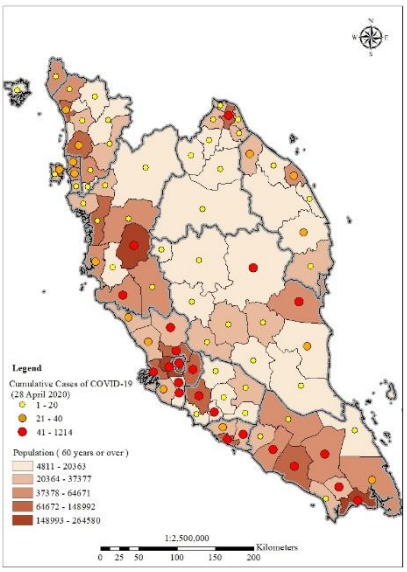
*Geografi Vol.8(2), 21-47*
*ISSN 2289-4470 /eISSN 2462-2400*



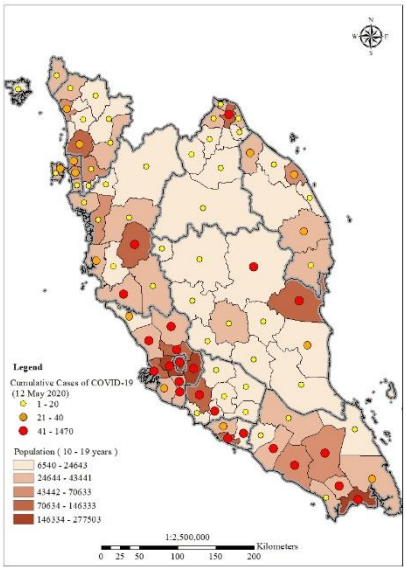

Map 16a: Spatial Distribution of the School-age Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 28th of April 2020



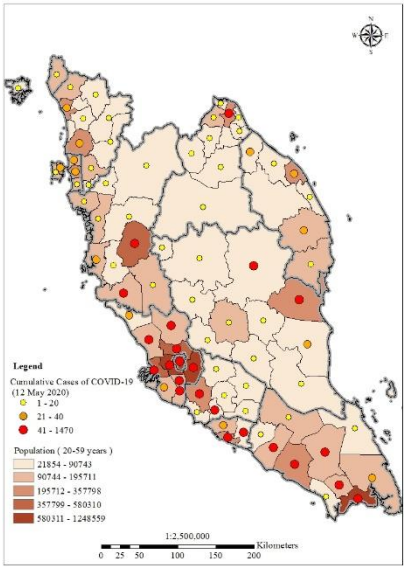

Map 17a: Spatial Distribution of the Productive Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 28th of April 2020



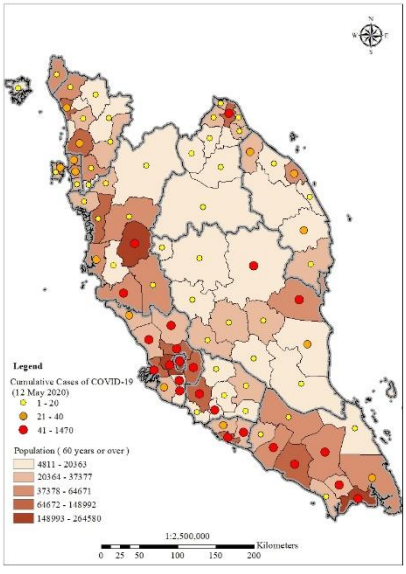

Map 18a: Spatial Distribution of the Aging Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 28th of April 2020



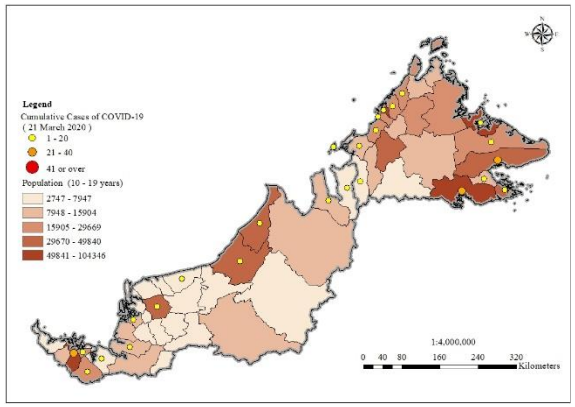

Map 19a: Spatial Distribution of the School-age Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 12th of May 2020



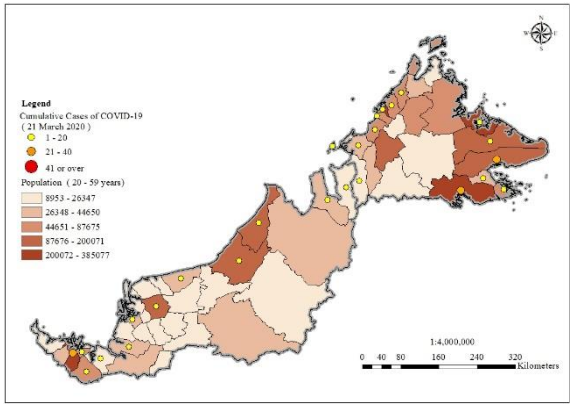

Map 20a: Spatial Distribution of the Productive Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 12th of May 2020



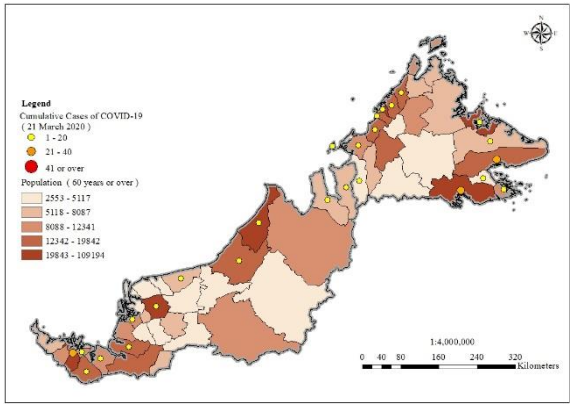

Map 21a: Spatial Distribution of the Aging Population and the COVID-19 Cumulative Cases in Peninsular Malaysia on 12th of May 2020



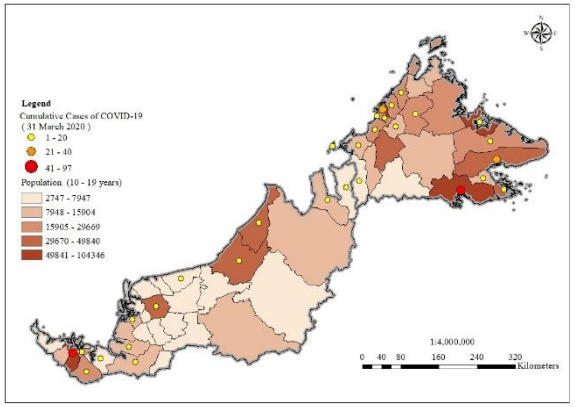

Map 7b: Spatial Distribution of the School-age Population and the COVID-19 Cumulative Cases in Sabah and Sarawak on 21st of March 2020



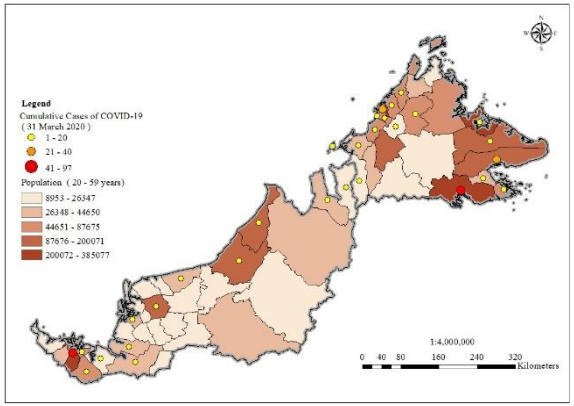

Map 8b: Spatial Distribution of the Productive Population and the COVID-19 Cumulative Cases in Sabah and Sarawak on 21th of March 2020



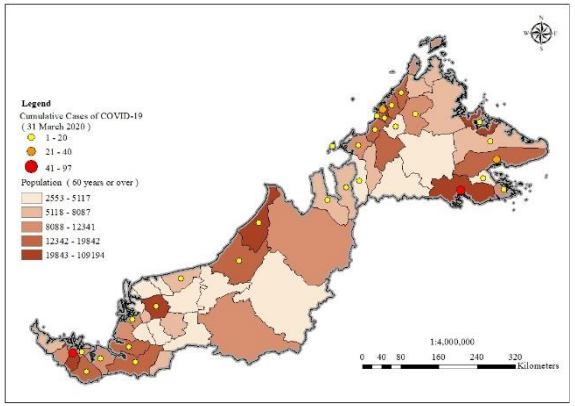

Map 9b: Spatial Distribution of the Aging Population and the COVID-19 Cumulative Cases in Sabah and Sarawak on 21th of March 2020




Map 10b: Spatial Distribution of the School-age Population and the COVID-19 Cumulative Cases in Sabah and Sarawak on 31st of March 2020

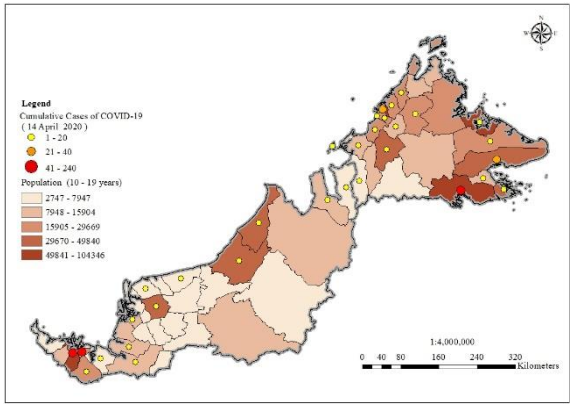



Map 11b: Spatial Distribution of the Productive Population and the COVID-19 Cumulative Cases in Sabah and Sarawak on 31th of March 2020

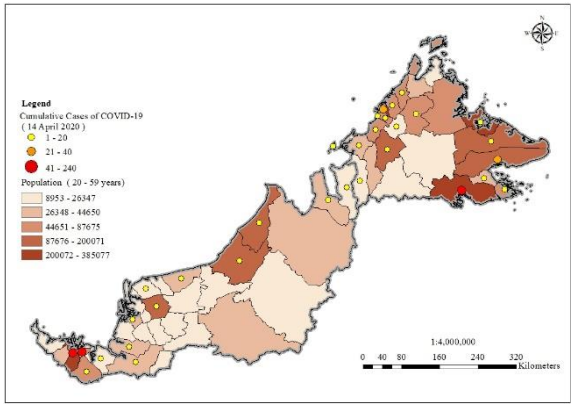



Map 12b: Spatial Distribution of the Aging Population and the COVID-19 Cumulative Cases in Sabah and Sarawak on 31th of March 2020

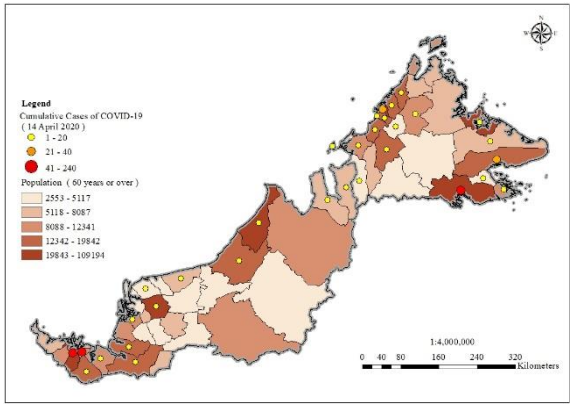
*Geografi Vol.8(2), 21-47*
*ISSN 2289-4470 /eISSN 2462-2400*



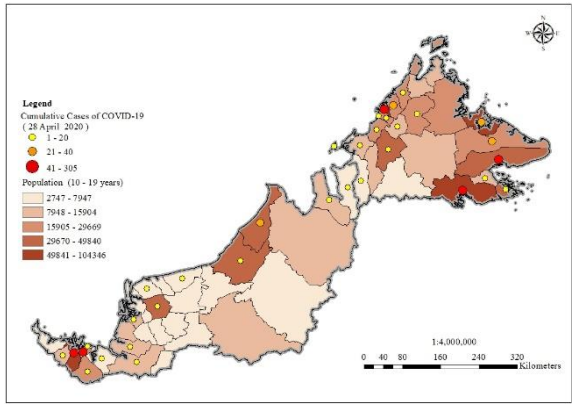

Map 13b: Spatial Distribution of the School-age Population and the COVID-19 Cumulative Cases in Sabah and Sarawak on 14th of April 2020



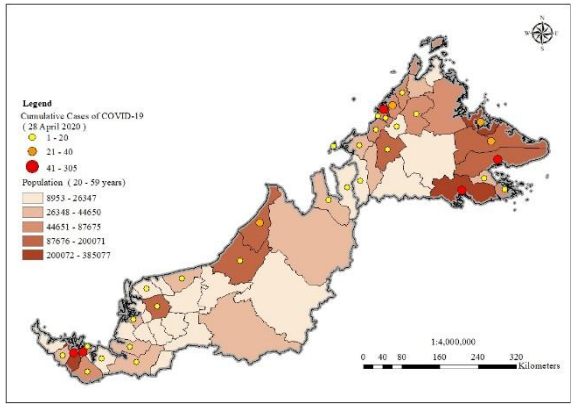

Map 14b: Spatial Distribution of the Productive Population and the COVID-19 Cumulative Cases in Sabah and Sarawak on 14th of April 2020



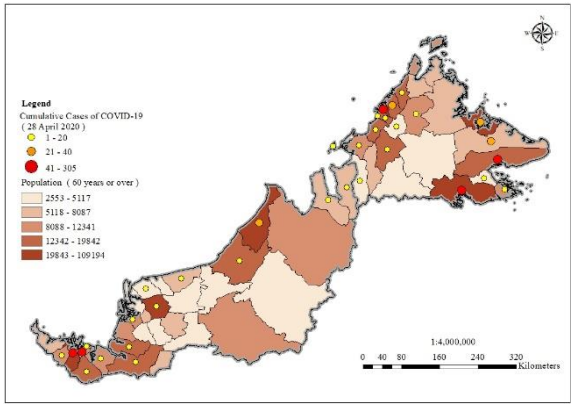

Map 15b: Spatial Distribution of the Aging Population and the COVID-19 Cumulative Cases in Sabah and Sarawak on 14th of April 2020



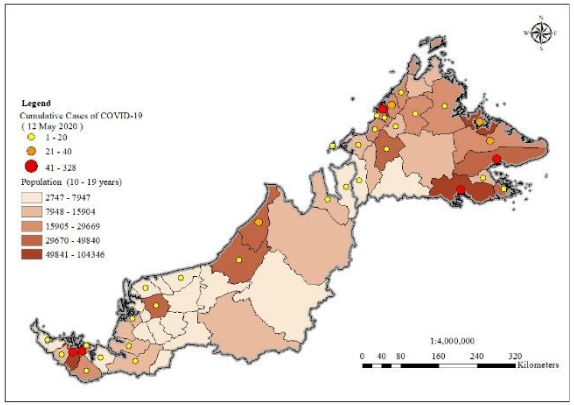

Map 16b: Spatial Distribution of the School-age Population and the COVID-19 Cumulative Cases in Sabah and Sarawak on 28th of April 2020



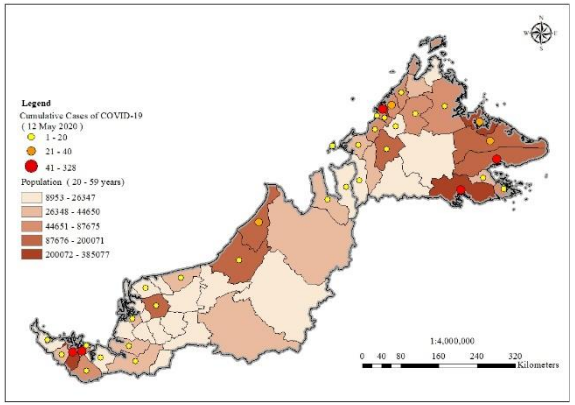

Map 17b: Spatial Distribution of the Productive Population and the COVID-19 Cumulative Cases in Sabah and Sarawak on 28th of April 2020



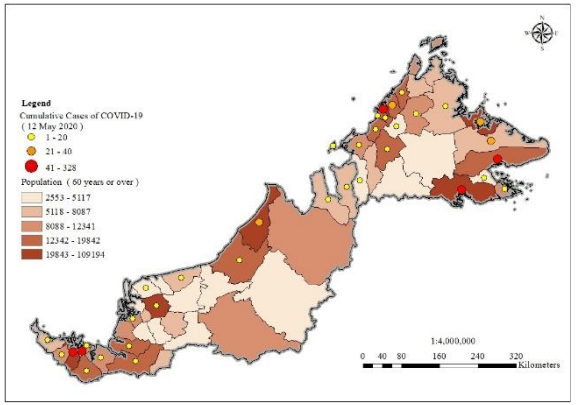

Map 18b: Spatial Distribution of the Aging Population and the COVID-19 Cumulative Cases in Sabah and Sarawak on 28th of April 2020




Map 19b: Spatial Distribution of the School-age Population and the COVID-19 Cumulative Cases in Sabah and Sarawak on 12th of May 2020




Map 20b: Spatial Distribution of the Productive Population and the COVID-19 Cumulative Cases in Sabah and Sarawak on 12th of May 2020




Map 21b: Spatial Distribution of the Aging Population and the COVID-19 Cumulative Cases in Sabah and Sarawak on 12th of May 2020

*Geografi Vol.8(2), 21-47*
*ISSN 2289-4470 /eISSN 2462-2400*

Table 1: Population Density and the Cumulative Cases of COVID-19

| State | District | Population Density | Population by Age Group (Year) | | | Cumulative Cases of COVID-19 (As on the selected dates in the year 2020) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (Person per km²) | 10 -19 | 20 -59 | 60 & over | 25th of January | 15th of February | 21st of March | 31st of March | 14th of April | 28th of April | 12th of May |
| **Federal Territory** | Kuala Lumpur | 6538 | 241080 | 1083090 | 264580 | 0 | 4 | 166 | 430 | 899 | 1214 | 1470 |
| | Putrajaya | 1395 | 16542 | 47008 | 4811 | 0 | 0 | 9 | 26 | 54 | 80 | 89 |
| **Johor** | Batu Pahat | 215 | 70633 | 250629 | 80640 | 0 | 0 | 23 | 39 | 51 | 53 | 53 |
| | Johor Bahru | 1254 | 241686 | 921241 | 171261 | 1 | 4 | 52 | 112 | 184 | 167 | 167 |
| | Kluang | 101 | 46949 | 184070 | 57345 | 0 | 0 | 26 | 107 | 201 | 222 | 222 |
| | Kota Tinggi | 54 | 32565 | 115508 | 39751 | 0 | 0 | 0 | 12 | 19 | 26 | 26 |
| | Kulai | 325 | 43079 | 169811 | 32404 | 0 | 0 | 5 | 23 | 38 | 45 | 45 |
| | Ledang | 136 | 23420 | 79428 | 29042 | 0 | 0 | 3 | 5 | 14 | 15 | 15 |
| | Mersing | 24 | 13314 | 40949 | 14765 | 0 | 0 | 1 | 3 | 4 | 4 | 4 |
| | Muar | 102 | 40768 | 144269 | 53990 | 0 | 0 | 13 | 27 | 44 | 52 | 52 |
| | Pontian | 163 | 26765 | 90743 | 32430 | 0 | 0 | 3 | 12 | 17 | 18 | 18 |
| | Segamat | 65 | 27877 | 112289 | 42819 | 0 | 0 | 1 | 9 | 15 | 20 | 20 |
| **Kedah** | Baling | 86 | 25530 | 79135 | 27639 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| | Bandar Baharu | 152 | 8014 | 24503 | 8835 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| | Kota Setar | 844 | 59629 | 215903 | 81644 | 0 | 2 | 10 | 22 | 26 | 28 | 28 |
| | Kuala Muda | 478 | 81781 | 283914 | 77793 | 0 | 0 | 23 | 30 | 35 | 35 | 35 |
| | Kubang Pasu | 227 | 36004 | 137792 | 40683 | 0 | 0 | 6 | 7 | 8 | 8 | 8 |
| | Kulim | 368 | 55368 | 184617 | 41275 | 0 | 0 | 1 | 7 | 13 | 13 | 13 |
| | Langkawi | 194 | 17324 | 63880 | 11580 | 0 | 2 | 3 | 4 | 4 | 4 | 4 |
| | Padang Terap | 46 | 11351 | 37552 | 13067 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| | Pendang | 149 | 16503 | 55502 | 21593 | 0 | 0 | 2 | 3 | 3 | 3 | 3 |
| | Pokok Sena | 199 | 8517 | 29271 | 10559 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sik | 41 | 12527 | 39593 | 14267 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| | Yan | 275 | 12829 | 38207 | 15570 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Kelantan** | Bachok | 452 | 26350 | 78054 | 21946 | 0 | 0 | 7 | 10 | 11 | 11 | 11 |
| | Gua Musang | 10 | 19904 | 54848 | 11437 | 0 | 0 | 1 | 2 | 2 | 2 | 2 |
| | Jeli | 29 | 9163 | 23922 | 6085 | 0 | 0 | 0 | 0 | 2 | 2 | 2 |
| | Kota Bharu | 1145 | 85019 | 302128 | 81291 | 0 | 0 | 29 | 80 | 90 | 90 | 90 |
| | Kuala Krai | 46 | 21875 | 64193 | 18166 | 0 | 0 | 8 | 10 | 11 | 11 | 11 |
| | Machang | 169 | 16508 | 55756 | 16854 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Pasir Mas | 316 | 35211 | 110026 | 35641 | 0 | 0 | 9 | 10 | 11 | 11 | 11 |
| | Pasir Puteh | 261 | 24100 | 67286 | 21805 | 0 | 0 | 4 | 8 | 8 | 8 | 8 |
| | Tanah Merah | 131 | 24643 | 71034 | 20272 | 0 | 0 | 0 | 3 | 6 | 7 | 7 |
| | Tumpat | 818 | 29088 | 90492 | 27599 | 0 | 0 | 3 | 8 | 13 | 13 | 13 |
| **Melaka** | Alor Gajah | 263 | 29769 | 110355 | 33588 | 0 | 0 | 6 | 14 | 28 | 29 | 28 |
| | Jasin | 419 | 23261 | 81206 | 27072 | 0 | 0 | 11 | 19 | 68 | 72 | 76 |
| | Melaka Tengah | 717 | 79518 | 315264 | 90103 | 0 | 0 | 5 | 19 | 51 | 92 | 53 |
| **Negeri Sembilan** | Jelebu | 28 | 6540 | 21854 | 9905 | 0 | 0 | 1 | 1 | 2 | 2 | 2 |
| | Jempol | 76 | 19300 | 66495 | 26945 | 0 | 0 | 1 | 4 | 12 | 13 | 14 |
| | Kuala Pilah | 59 | 10043 | 37332 | 16499 | 0 | 0 | 1 | 3 | 6 | 6 | 7 |
| | Port Dickson | 194 | 19973 | 72275 | 18743 | 0 | 0 | 3 | 6 | 9 | 9 | 12 |
| | Rembau | 104 | 7513 | 24792 | 9683 | 0 | 0 | 10 | 33 | 53 | 54 | 184 |
| | Seremban | 573 | 89784 | 357798 | 88565 | 0 | 2 | 42 | 119 | 261 | 333 | 356 |
| | Tampin | 94 | 14745 | 49167 | 18253 | 0 | 0 | 10 | 16 | 19 | 19 | 19 |
| **Pahang** | Bentong | 62 | 1 18778 | 73493 | 22126 | 0 | 0 | 4 | 6 | 15 | 19 | 19 |
| | Bera | 42 | 19155 | 58489 | 16461 | 0 | 0 | 0 | 9 | 9 | 9 | 12 |
| | Cameron Highlands | 134 | 6982 | 24913 | 5083 | 0 | 0 | 0 | 1 | 2 | 2 | 2 |
| | Jerantut | 12 | 18055 | 53565 | 16415 | 0 | 0 | 7 | 27 | 70 | 70 | 86 |
| | Kuantan | 150 | 89252 | 293558 | 60986 | 0 | 0 | 11 | 24 | 91 | 91 | 132 |
| | Lipis | 17 | 20265 | 51872 | 14347 | 0 | 0 | 0 | 3 | 9 | 9 | 9 |
| | Maran | 56 | 20721 | 67021 | 23314 | 0 | 0 | 0 | 5 | 6 | 6 | 6 |
| | Pekan | 27 | 21657 | 66255 | 17675 | 0 | 0 | 13 | 20 | 23 | 23 | 23 |

*Geografi Vol.8(2), 21-47*
*ISSN 2289-4470 /eISSN 2462-2400*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Raub | 40 | 17488 | 53915 | 20328 | 0 | 0 | 0 | 1 | 1 | 0 | 4 |
| | Rompin | 19 | 22145 | 69937 | 17766 | 0 | 0 | 0 | 2 | 3 | 0 | 3 |
| | Temerloh | 71 | 30188 | 99735 | 28801 | 0 | 0 | 2 | 4 | 7 | 0 | 16 |
| **Perak** | Batang Padang | 64 | 29603 | 106842 | 38873 | 0 | 0 | 1 | 5 | 9 | 9 | 9 |
| | Hilir Perak | 26 | 33661 | 120401 | 48531 | 0 | 0 | 13 | 57 | 65 | 65 | 65 |
| | Hulu Perak | 14 | 18929 | 53042 | 17955 | 0 | 0 | 0 | 5 | 6 | 6 | 6 |
| | Kampar | 144 | 12638 | 59183 | 24482 | 0 | 0 | 0 | 0 | 2 | 2 | 2 |
| | Kerian | 192 | 33846 | 105752 | 37377 | 0 | 0 | 7 | 13 | 19 | 19 | 19 |
| | Kinta | 574 | 108301 | 465168 | 176005 | 0 | 0 | 21 | 77 | 93 | 93 | 93 |
| | Kuala Kangsar | 759 | 26419 | 89118 | 40055 | 0 | 0 | 0 | 2 | 4 | 4 | 4 |
| | Larut and Matang | 155 | 54426 | 195711 | 76339 | 0 | 0 | 3 | 11 | 19 | 19 | 19 |
| | Manjung | 204 | 43441 | 139649 | 43981 | 0 | 0 | 4 | 12 | 22 | 22 | 22 |
| | Perak Tengah | 78 | 16827 | 64506 | 18521 | 0 | 0 | 6 | 7 | 11 | 11 | 11 |
| **Perlis** | Perlis | 275 | 35443 | 142242 | 47945 | 0 | 0 | 9 | 12 | 18 | 18 | 18 |
| **Pulau Pinang** | Barat Daya | 1120 | 32714 | 129238 | 35179 | 0 | 0 | 7 | 9 | 13 | 13 | 13 |
| | Seberang Perai Selatan | 686 | 30514 | 108112 | 28059 | 0 | 0 | 4 | 11 | 11 | 11 | 11 |
| | Seberang Perai Tengah | 1518 | 53935 | 244214 | 64671 | 0 | 0 | 8 | 32 | 40 | 40 | 40 |
| | Seberang Perai Utara | 1081 | 49245 | 183404 | 56043 | 0 | 0 | 4 | 15 | 23 | 23 | 25 |
| | Timur Laut | 4223 | 61319 | 324232 | 125445 | 0 | 0 | 27 | 27 | 32 | 32 | 32 |
| **Selangor** | Gombak | 1029 | 113438 | 456882 | 98374 | 0 | 0 | 38 | 62 | 141 | 141 | 234 |
| | Hulu Langat | 1372 | 187167 | 802039 | 148992 | 0 | 0 | 75 | 265 | 433 | 433 | 500 |
| | Hulu Selangor | 111 | 39709 | 128070 | 26608 | 0 | 0 | 3 | 12 | 49 | 61 | 61 |
| | Klang | 1470 | 146333 | 580310 | 115503 | 0 | 0 | 23 | 74 | 167 | 167 | 181 |
| | Kuala Langat | 257 | 43275 | 144054 | 32885 | 0 | 0 | 8 | 16 | 25 | 25 | 32 |
| | Kuala Selangor | 172 | 40477 | 134833 | 29947 | 0 | 0 | 17 | 19 | 35 | 35 | 49 |
| | Petaling | 3645 | 277503 | 1248559 | 239433 | 3 | 8 | 96 | 234 | 359 | 359 | 415 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sabak Bernam | 104 | 17983 | 62984 | 22742 | 0 | 0 | 0 | 2 | 23 | 24 | 27 |
| | Sepang | 346 | 41994 | 145533 | 19827 | 0 | 0 | 8 | 17 | 67 | 67 | 71 |
| **Terengganu** | Besut | 111 | 30412 | 84478 | 21673 | 0 | 0 | 7 | 16 | 32 | 32 | 35 |
| | Dungun | 55 | 32659 | 96829 | 20363 | 0 | 0 | 5 | 8 | 37 | 37 | 38 |
| | Hulu Terengganu | 18 | 13661 | 43970 | 13169 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Kemaman | 66 | 38479 | 106031 | 22240 | 0 | 0 | 1 | 3 | 5 | 5 | 5 |
| | Kuala Terengganu | 692 | 63201 | 216911 | 57441 | 0 | 0 | 12 | 18 | 22 | 22 | 22 |
| | Marang | 143 | 19251 | 60254 | 15778 | 0 | 0 | 1 | 1 | 2 | 2 | 2 |
| | Setiu | 42 | 12054 | 33810 | 8699 | 0 | 0 | 1 | 1 | 8 | 8 | 8 |
| **Federal Territory** | Labuan | 912 | 16627 | 58265 | 9028 | 0 | | 5 | 10 | 15 | 16 | 16 |
| **Sabah** | Beaufort | 37 | 13152 | 40715 | 10483 | 0 | 0 | 6 | 7 | 10 | 11 | 11 |
| | Beluran | 10 | 23497 | 73569 | 7418 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | Keningau | 49 | 40511 | 117554 | 15038 | 0 | 0 | 0 | 0 | 11 | 16 | 18 |
| | Kinabatangan | 2 | 29669 | 111953 | 5365 | 0 | 0 | 11 | 14 | 19 | 22 | 22 |
| | Kota Belud | 66 | 19391 | 58384 | 13497 | 0 | 0 | 5 | 5 | 5 | 5 | 5 |
| | Kota Kinabalu | 1292 | 88572 | 318563 | 44923 | 0 | 0 | 17 | 29 | 40 | 48 | 51 |
| | Kota Marudu | 35 | 15904 | 42383 | 8087 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Kuala Penyu | 42 | 3220 | 12147 | 3591 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Kudat | 65 | 19870 | 52561 | 10709 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Kunak | 54 | 11795 | 44650 | 4649 | 0 | 0 | 5 | 7 | 8 | 8 | 8 |
| | Lahad Datu | 31 | 47787 | 136594 | 15499 | 0 | 0 | 32 | 35 | 39 | 43 | 47 |
| | Nabawan | 5 | 7624 | 21630 | 2553 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Papar | 101 | 21950 | 87675 | 14795 | 0 | 0 | 1 | 2 | 4 | 4 | 4 |
| | Penampang | 262 | 22229 | 84517 | 15188 | 0 | 0 | 0 | 1 | 11 | 12 | 12 |
| | Pitas | 27 | 9293 | 23175 | 5340 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Putatan | 1843 | 11363 | 37462 | 5908 | 0 | 0 | 3 | 7 | 8 | 8 | 8 |
| | Ranau | 32 | 24890 | 58542 | 10660 | 0 | 0 | 0 | 2 | 2 | 3 | 3 |
| | Sandakan | 175 | 69945 | 286378 | 39967 | 0 | 0 | 8 | 16 | 20 | 21 | 21 |

*Geografi Vol.8(2), 21-47*
*ISSN 2289-4470 /eISSN 2462-2400*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Semporna | 116 | 37044 | 83779 | 12341 | 0 | 0 | 1 | 1 | 2 | 2 | 5 |
| | Sipitang | 13 | 6691 | 23962 | 4209 | 0 | 0 | 4 | 4 | 4 | 4 | 4 |
| | Tambunan | 26 | 8673 | 22722 | 4272 | 0 | 0 | 0 | 1 | 3 | 3 | 3 |
| | Tawau | 65 | 88236 | 270785 | 38652 | 0 | 0 | 37 | 63 | 79 | 81 | 83 |
| | Tenom | 23 | 11196 | 36530 | 7827 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Tongod | 4 | 10423 | 22141 | 2777 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Tuaran | 88 | 21033 | 67373 | 14005 | 0 | 0 | 6 | 12 | 20 | 22 | 22 |
| **Sarawak** | Asajaya | 103 | 6577 | 18091 | 6522 | 0 | 0 | 0 | 0 | 0 | 3 | 5 |
| | Bau | 60 | 10524 | 31940 | 10296 | 0 | 0 | 0 | 0 | 0 | 2 | 5 |
| | Belaga | 2 | 7552 | 23314 | 4381 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Betong | 15 | 11713 | 36014 | 13001 | 0 | 0 | 7 | 9 | 16 | 16 | 16 |
| | Bintulu | 92 | 34601 | 128959 | 19842 | 0 | 0 | 4 | 6 | 8 | 12 | 12 |
| | Dalat | 20 | 4023 | 10440 | 4060 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Daro | 15 | 5870 | 18988 | 5117 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Julau | 6 | 3131 | 8953 | 3365 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Kanowit | 13 | 5370 | 15792 | 7097 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Kapit | 4 | 11945 | 33724 | 9635 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Kuching | 320 | 104346 | 385077 | 109194 | 0 | 0 | 30 | 97 | 240 | 305 | 328 |
| | Lawas | 10 | 7947 | 23033 | 6232 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| | Limbang | 15 | 10060 | 29398 | 7522 | 0 | 0 | 5 | 6 | 8 | 9 | 9 |
| | Lubok Antu | 9 | 4746 | 15917 | 6700 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Lundu | 18 | 7053 | 19645 | 5870 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | Marudi | 3 | 12788 | 38063 | 12032 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Matu | 11 | 3377 | 9950 | 3625 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| | Meradong | 26 | 6336 | 16713 | 5664 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Miri | 62 | 49840 | 200071 | 40363 | 0 | 0 | 8 | 10 | 15 | 23 | 23 |
| | Mukah | 16 | 7333 | 27785 | 6363 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| | Pakan | 16 | 2747 | 8994 | 3398 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Samarahan | 210 | 20204 | 56290 | 9001 | 0 | 0 | 2 | 11 | 51 | 89 | 96 |
| | Saratok | 28 | 8654 | 26347 | 10014 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sarikei | 57 | 10654 | 35398 | 10176 | 0 | 0 | 4 | 5 | 6 | 6 | 6 |
| | Selangau | 6 | 5009 | 12488 | 4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Serian | 44 | 16881 | 53950 | 18247 | 0 | 0 | 2 | 4 | 7 | 13 | 20 |
| | Sibu | 108 | 43445 | 156597 | 40123 | 0 | 0 | 1 | 3 | 5 | 5 | 6 |
| | Simunjan | 28 | 7652 | 22195 | 8477 | 0 | 0 | 1 | 1 | 3 | 7 | 7 |
| | Song | 5 | 4383 | 11337 | 4385 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Sri Aman | 28 | 12530 | 37710 | 14260 | 0 | 0 | 0 | 1 | 1 | 2 | 3 |
| | Tatau | 6 | 6069 | 19211 | 4312 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

*Geografi Vol.8(2), 21-47*
*ISSN 2289-4470 /eISSN 2462-2400*

## 5. Conclusion

In conclusion, the density of school-age population, productive population and aging population was high and concentrated in major cities in Malaysia such as Federal Territory of Kuala Lumpur, Petaling, Kuching, Miri, Sibu and Kota Kinabalu. The cumulative number of COVID-19 cases was also high in those areas. However, in detail, the risk is more vulnerable in the cities with a high number of the aging population as they are more prone to get infected. Plus, based on the daily statistics, the deaths among the COVID-19 patients are mostly among the elderly. Therefore, extra mitigation must be focused on the cities with a high number of the aging population. Statistical COVID-19 record, with the help of GIS as a spatial-based tool, is practicable in clarifying, quantifying and identifying the risky areas. As applied in this research paper, the relation between the total number of population and spatial distribution of COVID-19 is expected to provide information for the implementation of preventive measures among the population in Malaysia. Most importantly, the results from the integration between epidemiology with geography have shown to be beneficial for the authorities, especially the Malaysian Government as well as the public health policy makers to promote strategies for COVID-19 control and management. Besides, GIS that acts as a spatial-based tool is applicable widely for other countries to cope with the current and future possible outbreak.

## References

Boulos, M. N. K & Geraghty, E. M. (2020) Geographical tracking and mapping of coronavirus disease COVID-19/severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) epidemic and associated events around the world: how 21st century GIS technologies are supporting the global fight against outbreaks and epidemics. *International Journal Health Geographics, 19*(8), 1-12.

Busiai, S. and Tarmiji, M. (2019). Hotspot Analysis of Hand Foot and Mouth Disease (HFMD) Using GIS in Kuching, Sarawak, Malaysia. *Humanities & Social Sciences Reviews*, 7(2), 36-44.

Chen, Z. L., Zhang, Q., Lu, Y., Guo, Z. –M., Zhang, X., Zhang, W. –J., Guo, C., Liao, C. –H., Li, Q. –L., Han, X. –H., Lu, J. –H. (2020). Distribution of the COVID-19 Epidemic and Correlation with Population Emigration from Wuhan, China**.** *Chinese Medical Journal.* DOI: 10.1097/CM9.0000000000000782

Dhama, K., Khan, S., Tiwari, R., Sircar, S., Bhat, S., Malik, Y. S., Singh, K. P., Chaicumpa, W., Bonilla-Aldana, D. K. & Rodriguez-Morales, A. J. (2020). Coronavirus Disease 2019 – COVID-19. DOI: 10.20944/preprints202003.0001.v2

ESRI (2020). European Centre for Disease Prevention and Control.

Fatemeh, S. and Leila, A. (2017). The Application of Geographic Information Systems (GIS) In Identifying the Priority Areas for Maternal Care and Services. *Health Services Research, 17*(482), 1-8.

Gennaro, F. D., Pizzol, D., Marotta, C., Antunes, M., Racalbuto, V., Veronese, N. and Smith, L. (2020). Coronavirus Diseases (COVID-19) Current Status and Future Perspectives: A Narrative Review. *International Journal of Environmental Research and Public Health, 17*(2690), 1-11.

Hackoum, E. W. & Abdallah, A. T. M. (2020). Analysis of Covid-19 Outbreak Using Multispectral-Near Real-Time Satellites Surveillance. DOI: 10.13140/RG.2.2.28693.27360

Hamidi, S., Sabouri, S. and Ewing, R. (2020). Does Density Aggravate the COVID-19 Pandemic? *Journal of the American Planning Association,* 1-15. DOI: 10.1080/01944363.2020.1777891

Jella, T. K., Acuña, A. J., Samuel, L. T., Jella,T. K., Mroz, T. E. and Kamath, A. F. (2020). Geospatial Mapping of Orthopaedic Surgeons Age 60 and Over and Confirmed Cases of COVID-19. *J. Bone Joint Surg. Am.* DOI: 10.2106/JBJS.20.00577

Jubit, N., Masron, T. and Marzuki, A. (2020). Spatial Pattern of Residential Burglary. The Case Study: Kuching, Sarawak. *Journal of the Malaysian Institute of Planners, 18*(3), 190 – 201.

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*(2020), 96 – 102.

Kementerian Kesihatan Malaysia (KKM). (2020).

Kenyataan Akhbar KPK 25 Januari 2020 – Pengesanan Kes Baharu yang Disahkan Dijangkiti 2019 Novel Coronavirus (2019-nCoV) di Malaysia. [cited March 2020]. Available from: https://kpkesihatan.com/2020/01/25/ kenyataan-akhbar-kpk-25-januari-2020-pengesanan-kes-baharu-yangdisahkan-dijangkiti-2019-novel-coronavirus-2019-ncov-di-malaysia/.

Kenyataan Akhbar YBMK 17 Mac 2020 – Situasi Semasa Jangkitan Penyakit Coronavirus 2019 (COVID-19) di Malaysia. [cited March 2020]. Available from: https://kpkesihatan.com/2020/03/17/kenyataan-akhbarybmk-17-mac-2020-situasi-semasa-jangkitan-penyakit-coronavirus-2019- covid-19-di-malaysia/.

Kenyataan Akhbar KPK 1 Februari 2020 – Situasi Terkini Jangkitan 2019 Novel Coronavirus (2019-nCoV) di Malaysia. [cited March 2020]. Available from: https://kpkesihatan.com/2020/02/01/kenyataan-akhbarkpk-1-februari-2020-situasi-terkini-jangkitan-2019-novel-coronavirus2019-ncov-di-malaysia/.

Kenyataan Akhbar KPK 9 Februari 2020 – Situasi Terkini Jangkitan 2019- nCoV dan Pengesanan Kes Baharu di Malaysia. [cited March 2020]. Available from: https://kpkesihatan.com/2020/02/09/kenyataan-akhbarkpk-9-februari-2020-situasi-terkini-jangkitan-2019-ncov-danpengesanan-kes-baharu-di-malaysia/.

Kenyataan Akhbar KPK 15 Februari 2020 – Situasi Terkini Jangkitan COVID-19 dan Pengesanan Kes Baharu Ke-22 di Malaysia. [cited March 2020]. Available from: https://kpkesihatan.com/2020/02/15/kenyataanakhbar-kpk-15-februari-2020-

*Geografi Vol.8(2), 21-47*
*ISSN 2289-4470 /eISSN 2462-2400*

situasi-terkini-jangkitan-covid-19-danpengesanan-kes-baharu-ke-22-di-malaysia/.

Maxwell, D. N., Trish, M. P., & Cutrell, J. B. (2020). "The Art of War" in the Era of Coronavirus Disease 2019 (COVID-19). *Clinical Infectious Diseases*. DOI: https://doi.org/10.1093/cid/ciaa229

Mclafferty, S. (2003). GIS and healthcare, *Annual Review of Public Health 24*(1), 25-42.

Minetto, R., Segundo, M. P., Rotich, G. and Sarkar, S. (2020). Measuring Human and Economic Activity from Satellite Imagery to Support City-Scale Decision-Making During COVID-19 Pandemic.

Mohd Norarshad, N. and Tarmiji, M. (2016). Analisis Ruangan Hotspot Penyalahgunaan Dadah di Malaysia: Kajian Kes Daerah Timur Laut, Pulau Pinang. *GEOGRAFIA Online Malaysian Journal of Society and Space, 12*(5), 74 – 82.

Musa, G. J., Chiang, P. –H., Sylk, T., Bavley, R., Keating, W., Lakew, B., Tsou, H. –H., and Christina W. Hoven, C.W. (2013). Use of GIS Mapping as a Public Health Tool—From Cholera to Cancer. *Health Services Insights, 6,* HSI.S10471.

Singh, J. K., Yadav, K. K., Gupta, N. and Kumar, V. (June 2016). *Remote Sensing and Geographical Information System (GIS) and Its Application in Various Fields.* National Conference on Energy and Environment: Threats and Remedies, RJIT Tekanpur, Gwalior. Available at: https://www.researchgate.net/publication/312577535_Remote_Sensing_and_Geographical_Information_System_GIS_and_Its_Application_in_Various_Fields

Snow, J. (1855). *On the Mode of Communication of Cholera.* London: John Churchill, New Burlington Street.

Ruslam Rainis, Noresah Mohd Shariff dan Tarmiji Masron. (2006). *Perubahan Konsentrasi Ruangan Penduduk di semenanjung Malaysia 1980-2000* dalam *Malaysian Journal of Society and space*. Vol.2 Issue 1(31-42).

Suleman, S., Rida, W., Sahar, S and Aisha, K. (2020). COVID-19 Challenges to Pakistan: Is GIS Analysis Useful to Draw Solutions? *Science of the Total Environment, 730*(2020), 1-7.

Tang, T., Huipeng, L., Gifty, M., Zaisheng, W., Weibin, C., Dan, W. and Rongbin, Y. (2020). The Changing Patterns of Coronavirus Disease 2019 (COVID-19) in China: A Tempogeographic Analysis of the Severe Acute Respiratory Syndrome Coronavirus 2 Epidemic. *Clinical Infectious Diseases Major Article, 71*(15), 818–24. DOI: 10.1093/cid/ciaa423

Tarmiji Masron, Danggat Chabo, Nur Faziera Yaakub, Ailis Elizabeth Epa, Ahmad Hata Rasit, Mohd Suhaidi Salleh, Shahrizal Hashim, Mohd Hairulnizam Mohd Zamri. (2020). Coronavirus (COVID-19) Post-Control Study of University Students: Case Study of Spatial Distribution of Universiti Malaysia Sarawak (UNIMAS) Students and National COVID-19 Cases. Centre for Spatially Integrated Digital Humanities, Faculty of Social Sciences and Humanities Universiti Malaysia Sarawak, Kota Samarahan, Sarawak.

Tarmiji Masron, Hassan Naziri Khalid, Nur Faziera Yaakub, Siti Khatijah Zamhari and Fujimaki Masami. (2019). Tin Mining Activities and Sustainability of Mining-Based Cities in Peninsular Malaysia. *The Journal of Ritsumeikan Geographical Society, 31,* 27-51.

Tarmiji Masron, Wan Muhammad Taufik Wan Hussin, Mohd Norarshad Nordin, Nur Faziera Yaakub and Mohd Azizul Hafiz Jamian. (2018). Applying GIS in Analysing Black Spot Areas in Penang, Malaysia. *Indonesian Journal of Geography 50*(2), 133-144.

Unhale, S. S., Ansar, Q. B., Sanap, S., Thakhre, S., Wadatkar, S., Bairagi, R., Sagrule, S. and Biyani, K. R. (2020). A REVIEW ON CORONA VIRUS (COVID-19). *International Journal of Pharmaceutical and Life Sciences, 6*(4), 109-115.

World Health Organization (WHO). (2020a). CORONAVIRUS DISEASE (COVID-19) OUTBREAK: RIGHTS, ROLES AND RESPONSIBILITIES OF HEALTH WORKERS, INCLUDING KEY CONSIDERATIONS FOR OCCUPATIONAL SAFETY AND HEALTH. Available at: https://www.who.int/docs/default-source/coronaviruse/who-rights-roles-respon-hw-covid-19.pdf?sfvrsn=bcabd401_0

World Health Organization (WHO). (2020b). *Coronavirus disease 2019 (COVID-19) Situation Report – 94.* Available at: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200423-sitrep-94-covid-19.pdf?sfvrsn=b8304bf0_4

Zhang, X., Rao, H. –X., Wu, Y., Huang, Y. and Dai, H. (2020). Comparison of the Spatiotemporal Characteristics of the COVID-19 and SARS Outbreaks in Mainland China. *MedRxiv.* DOI: https://doi.org/10.1101/2020.03.23.20034058

Bernama (2020). 26-30 dan 56-60 dua golongan umur paling tinggi kes positif COVID-19. http://www.astroawani.com/berita-malaysia/26-30-dan-56-60-dua-golongan-umur-paling-tinggi-kes-positif-covid-19-236197.