



GEO-SPATIAL BIG DATA ANALYSIS OF COVID-19 FOR SOUTHEAST ASIAN COUNTRIES SITUATED AT LATITUDE BELOW 38°N

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ABSTRACT: The outbreak of the Covid-19 originated from Wuhan City, quickly spread across China and beyond following human mobility patterns covering more than 210 countries of the globe, and World Health Organization (WHO) declared the outbreak a pandemic on 11 March 2020. The outbreak of Covid-19 spread geo-spatial and spatiotemporal way in countries situated at latitude between 64°N and 35°S, causing more than 182.969 million (182,969,081) people of the global population infected and 3.963 million (3,963,102) deaths (as on 30 June 2021). The spatial spreading of covid-19 spectrum due to large-scale migrations were reported in the southeast Asian region, with the first case in Thailand on 13 January 2020, which is followed by South Korea on 20 January 2020, and Vietnam and Taiwan on 22 January 2020 prior to reach Hong Kong and Singapore on 23 January 2020. Malaysia reported the first covid-19 case on 25 January 2020, which further spread to Philippines on 30 January 2020 prior to reach Indian Sub-continent on 31 January 2020. There are marked variations in the spectrum of daily new Covid-19 cases and population mortality between different countries in the Southeast Asian region such as India, South Korea, Taiwan, Vietnam, Singapore, Thailand, Malaysia, Indonesia, Philippines, Hong-Kong, and Myanmar. In this paper, spatial big data predictive analysis have been carried out based 5-days moving averages of new covid-19 cases from 19 February 2020 to 30 June 2021, which shows multiple surge of covid-19 spectrum in the southeast Asian region. This paper further describes the impact of latitude on population mortality for determining the severity of the outbreak based on population mortality data of 28 countries situated at latitude below 64°N from 15 April 2020 to 20 January 2021, whereas relatively lower population mortality observed for the countries situated at latitude below 38°N.

1. INTRODUCTION

The outbreak of the covid-19 emerged from Wuhan and spread throughout the Hubei province of China, and further spatially transmitted in an exponential spread to more than 210 countries. World Health Organization (WHO) declared the outbreak a pandemic on 11 March 2020. The outbreak of Covid-19 spread geo-spatial and spatiotemporal way in countries situated at latitude between 64°N and 35°S, which spread globally creating a public health emergency of international concern causing more than 182.969 million people of the global population infected and 3.963 million deaths (as on 20 January 2021) compared to 96.7 million people infected and 2.06 million deaths (as of 20 January 2021). The exponential spreading of Covid-19 spectrum to the new geographical locations has seriously threatened the human health as well as posed the challenges to control the severity of the outbreak. The outbreak of covid-19 seriously threatened the life of the people as well as affecting economic and social development (BBC, 2020; Corona virus, 2020; Chenghu Z. et al, 2020). The spatial spreading of covid-19 also resulted outbreak in the southeast Asian region, covering the latitude of 38°N to 6°S, with the first reported covid-19 case at Thailand on 13 January 2020, followed by South Korea on 20 January 2020 as well as Vietnam and Taiwan on 22 January 2020. The first covid-19 case was then reported in Hong Kong and Singapore on 23 January 2020, which was followed by Malaysia on 25 January 2020 and Philippines on 30 January 2020, prior to reaching India on 31 January 2020 (BBC, 2020).

The Hong Kong, Vietnamese and South Korean governments imposed national lockdowns / recommendations to control the outbreak of the covid-19 spectrum to control the exponential rise of the spectrum of covid-19 from 8th, 13th and 20th February 2020 respectively, after 16, 22 and 31 days of the first covid-19 reported case. The governments of Singapore, Malaysia, Philippines, Thailand, Taiwan and India imposed these measures from 6th, 13th, 15th, 20th, 24th and 25th March 2020 respectively, whereas, the Indonesian government imposed a national lockdown from 15th March 2020, after 13 days of the first covid-19 reported case. The Myanmar's government executed a national lockdown on 13th March 2020, prior to the arrival of first covid-19 case on 27th March 2020, which was found to be most effective to control its outbreak and keep the country in the safest zone (BBC, 2020).



The design of different spatial measures of the national lockdown/ recommendations/ health emergency measures, such as surveillance, identification, testing, tracking, segregating the different zones and medical treatment to control the outbreak of covid-19 spectrum, differs for different countries of the Southeast Asian region depending of populations, geographical area, socio-economic conditions, existing medical infrastructure and supply chain management for different activities. Covid-19 geo-spatial big data analysis plays an important role for predicting the trend of the spectrum and suggesting different measures including supply chain infrastructure to control the outbreak by using geographical information systems (GIS) technologies (Chenghu Z. et al, 2020). The exponential spreading of Covid-19 spectrum has seriously threatened the human health and life of the people as well as posed the challenges for countries to control the severity of the outbreak.

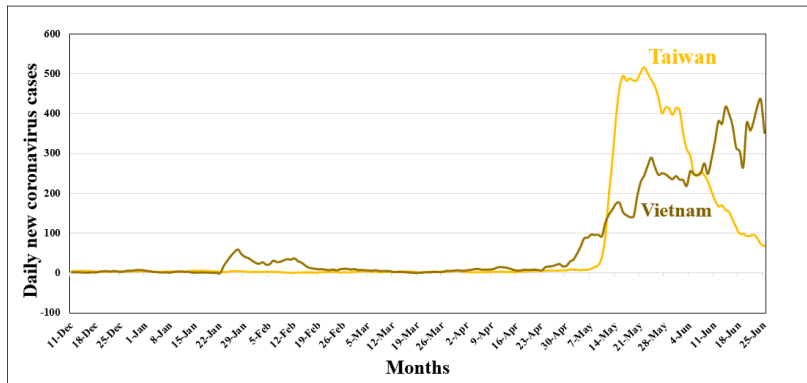
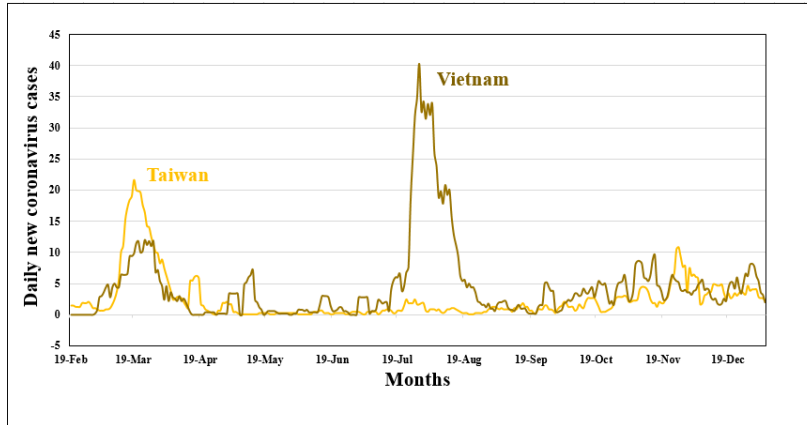
When mortality per million populations was plotted against latitude for 120 countries located in the Northern and Southern Hemispheres based on the mortality data for 15 April 2020, it showed marked variation in mortality among different countries, highlighting the importance of nutrition and vitamin D (Jonathan M.R. et al, 2020; Panarese A. and Shahini E., 2020). Countries situated beyond the latitude of 35 °N and 35 °S, people do not receive sufficient sunlight to retain adequate vitamin D levels and showed relatively higher population mortality. The variation of population mortality from covid-19 from 15 April to 06 June 2020 for countries of the southeast Asian region situated at the latitude between 35 °N to 6 °S showed relatively lower mortality as compared to the countries situated at latitude above 35°N (Verma A.K. et al, 2020; Verma A.K. et al, 2020). Further, significant variation of variability factor of population mortality from 15 April to 06 June 2020 for 28 countries that lie at the latitude between 60°N to 35°S showed as a determining factor for the severity of the outbreak.

In this paper, spatial big data predictive analysis have been carried out based 5-days moving averages of new covid-19 cases from 19 February 2020 to 30 June 2021 and Population Mortality data from 15 April 2020 to 30 January 2020. This paper further describes the impact of latitude on variability factor of population mortality and different peaks of covid-19 spectrum for the Southeast Asian region.

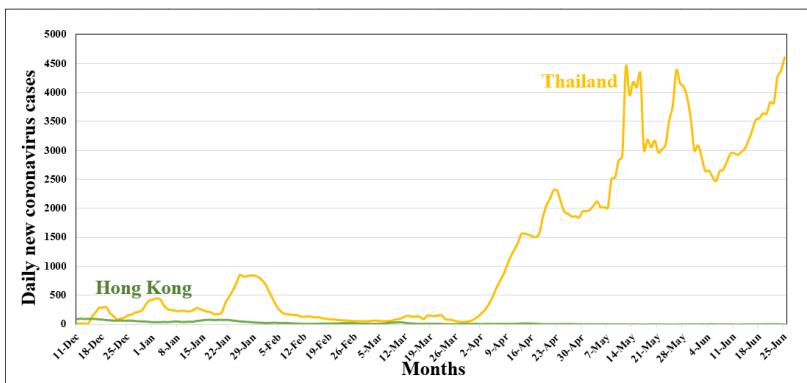
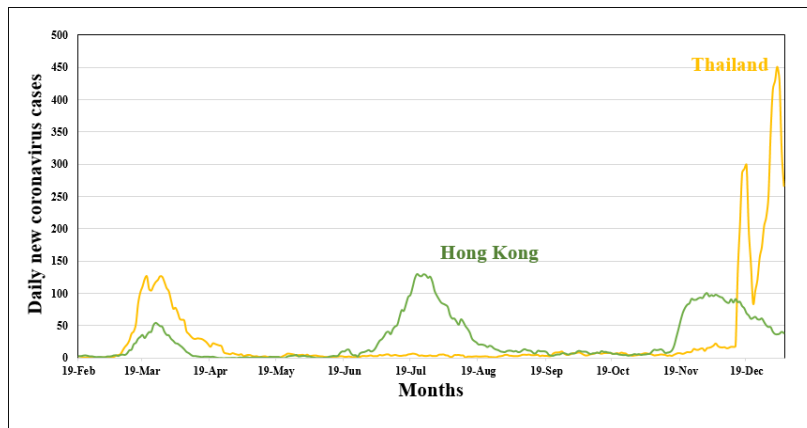
2. Covid-19 Spectrum in Southeast Asian Region

Figure 1 depicts the variation of the spectrum of 5 days moving average of daily new covid-19 cases from 19 February 2020 to 10 January 2021 for 11 countries of the southeast Asian region. The spectrum of coronavirus outbreak increased exponentially to reach the first peak of the spectrum prior to decrease exponentially to attain the stability for South Korea during February 2020, whereas the spectrum for Vietnam, Hong Kong, Malaysia, Thailand, Malaysia and Taiwan attained first peak during March 2020. Further, the spectrum of coronavirus increased exponentially to reach first peak of the spectrum prior to decrease exponentially to attain the stability for Singapore in April 2020, whereas the spectrum for Indonesia, Myanmar and India attained the first peak during September 2020. The coronavirus spectrum of Phillipines attained the first peak during August 2020. The spectrum of coronavirus outbreak increased non-linearly to reach first peak during April 2020 for Singapore and decreases non-linearly with multiple lower peaks, whereas non-linear exponential increase of the spectrum of Phillipines and India attained the first peak of the spectrum during August and September 2020 respectively prior to decrease exponentially.

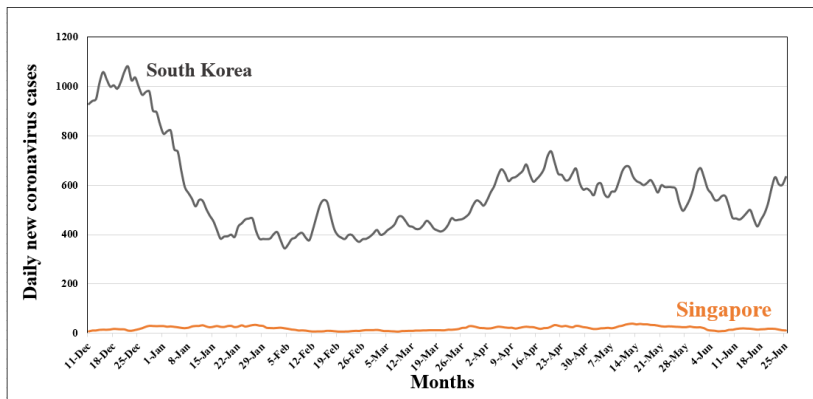
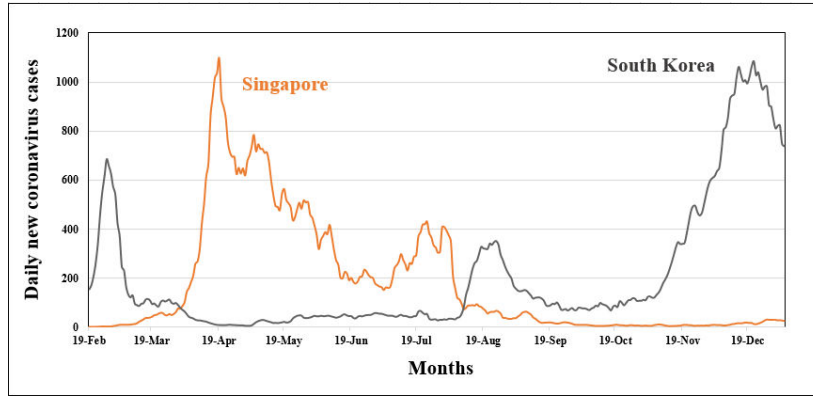
The covid-19 spectrum attained first, second and third peak of the spectrum for Hong Kong, Taiwan, Vietnam, and Indonesia, whereas the spectrum attained first and second peak for Singapore, Myanmar and India during the period of February 2020 to June 2021, which resulted into the imposition of strict lockdown measures to control the outbreak as depicted in Figure 1 (a) and Figure 1 (f). The coronavirus spectrum attained first, second, third and fourth peak of the outbreak for Malaysia, Phillipines, South Korea and Thailand as depicted in Figure 1(b) to Figure 1(d). The complete recovery of the outbreak is observed for Taiwan, Hong Kong and Vietnam after attaining the first, second and third peak of the spectrum as depicted in Figure 1(a) and Figure 1(b), whereas, Singapore and Myanmar attained to the complete recovery after attaining the first and second peak of the spectrum as shown in Figure 1(c) and Figure 1(d). Figure 1(a) depicts third peak of coronavirus spectrum of Taiwan and Vietnam 25 times, and 40 times during May 2021 compared to first peak during March 2020. Figure 1(b) depicts third peak of coronavirus spectrum of Hong Kong and Thailand 2 times and 40 times during May 2021 compared to first peak during March 2020. Figure 1(c) and Figure 1(d) depicts fourth peak of coronavirus spectrum of South Korea, Malaysia and Phillipines 10 times, 40 times and 2.5 times during May 2021 compared to first peak during February, March and July 2020 respectively. Figure 1(c), Figure 1(d) and Figure 1(f) depicts second peak of coronavirus spectrum of Singapore, Myanmar and India 0.4 times, 1.0 times and 4.0 times during July 2020, November 2020 and May 2021 respectively, compared to first peak during April, October and September 2020 respectively. Figure 1(e) depicts third peak of coronavirus spectrum of Indonesia 5.0 times during June 2021, compared to first peak during September 2020.



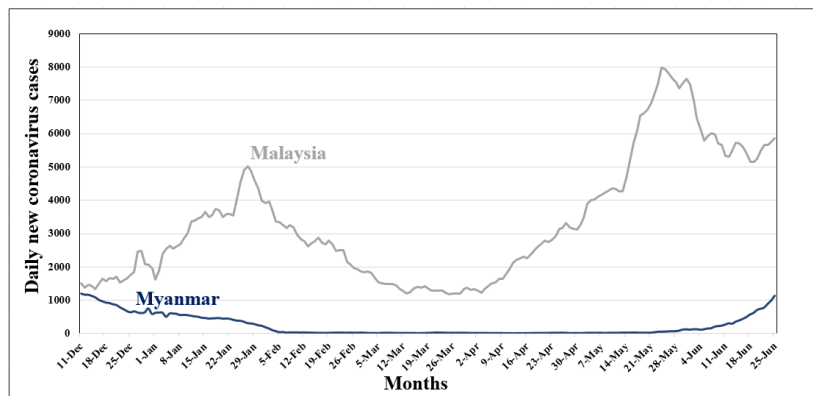
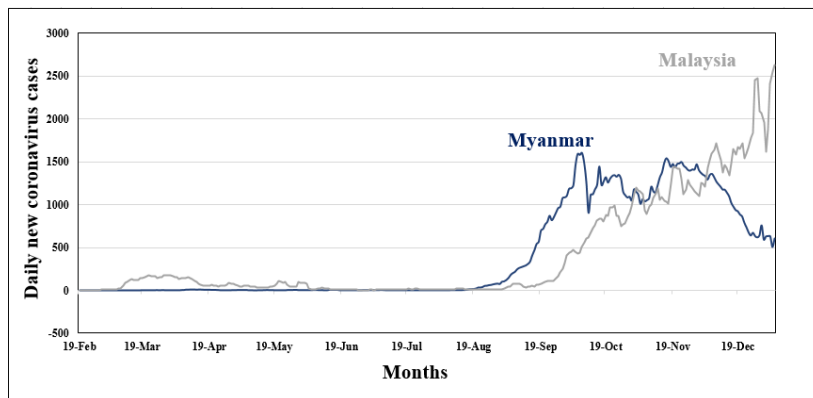
(a)



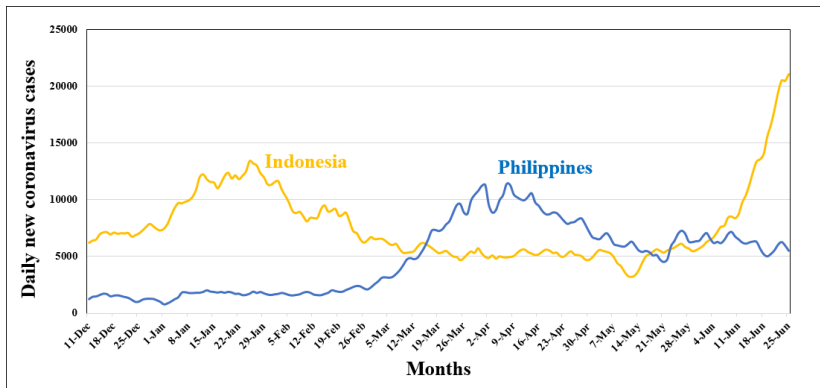
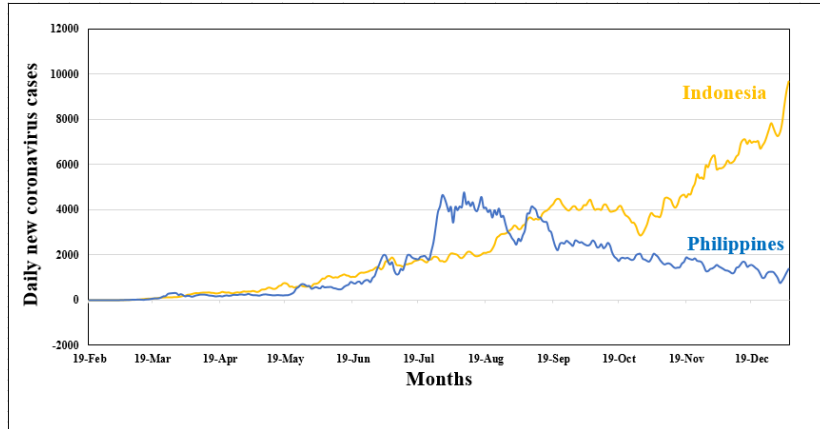
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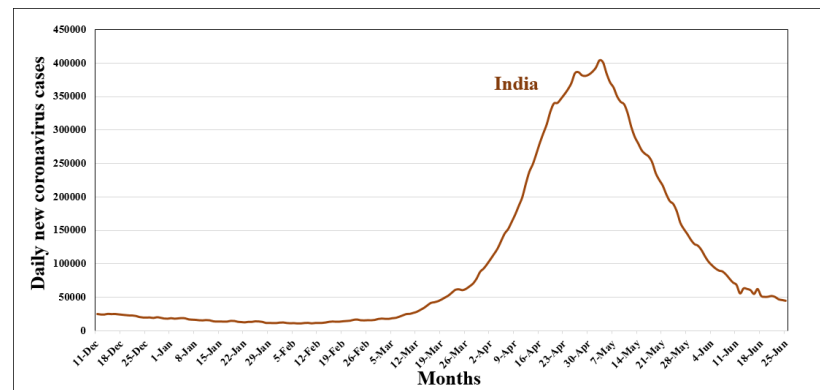
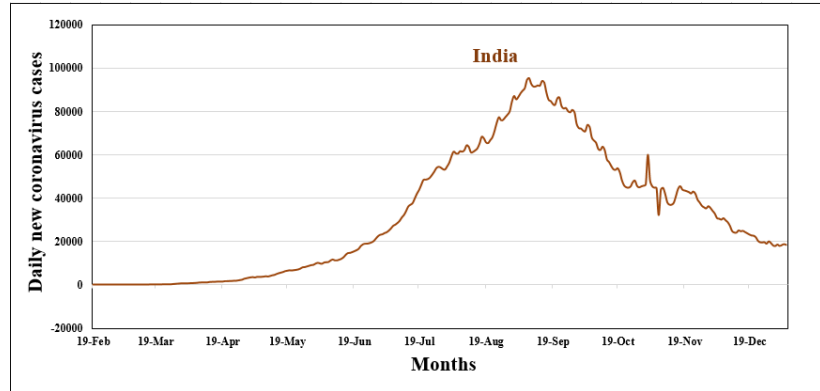
(c)



(d)



(e)



(f)

Figure 1: Covid-19 spectrum from 19 February 2020 to 10 January 2021.

3. IMPACT OF LATITUDE ON POPULATION MORTALITY

Higher population mortality from covid-19 observed in northern latitude with highest in Italy and exhibiting the population mortality with decreasing north south gradient based on mortality data of 02 April 2020 for 108 countries (Jonathan M.R. et al, 2020). Northern latitudes are associated with vitamin D deficiency for higher population mortality due to low ultraviolet exposure in the northern countries. when population mortality plotted against the latitude for 130 countries based on mortality data of 15 April 2020 showed marked variation in mortality between different countries that lie below the latitude of 64°N of the hemisphere (Panarese A. and Shahini E., 2020). People do not receive adequate sunlight to maintain vitamin D levels during winter in countries situated beyond the latitude of 35°N. All countries that lie below the latitude of 35°N showed relatively low population mortality with the correlation coefficient of 0.53 between mortality and latitudes (Jonathan M.R. et al, 2020; Panarese A. and Shahini E., 2020). Relatively low population mortality from covid-19 observed for countries situated at latitudes between 38°N and 35°S based on population mortality from 15 April to 08 June 2020 for 28 countries and 15 April to 15 August 2020 for 52 countries that lie below the latitude 60°N (Verma A.K. et al, 2020; Verma A.K. et al, 2020), which confirms to higher correlations due to continuance of multiple peaks for countries at the same latitudes during these periods with increased population mortality.

3.1 Population Mortality for the Southeast Asian Region

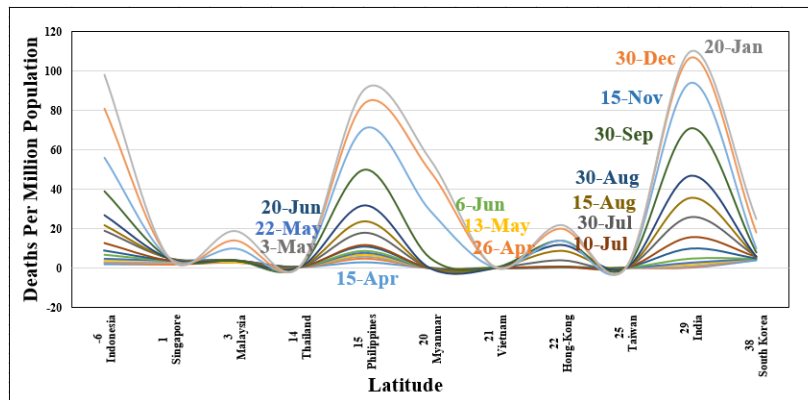
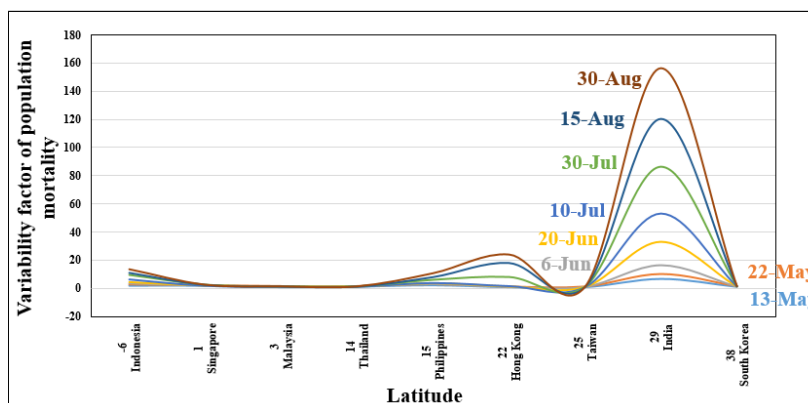


Figure 2: Variation of population mortality for Southeast Asian Region

Figure 2 depicts the variation of population mortality from Covid-19 for 11 countries of the Southeast Asian region that lie between latitudes 38°N and 6°S based on population mortality data from 15 April to 30 August 2020 and 15 April 2020 to 20 January 2021. There are significant variations in population mortality for Malaysia, Myanmar, Hong Kong, whereas other countries showed non-significant variations in population mortality. Further, a sudden rise of population mortality observed for Myanmar, Malaysia and Hong-Kong during 15 November 2020 to 20 January 2021, in addition to the continuance of the rise of population mortality for Indonesia, Philippines and India in the Southeast Asian region.



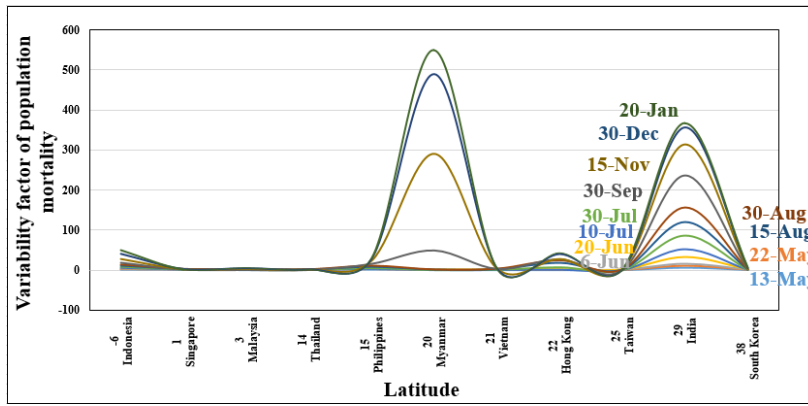


Figure 3. Variation of variability factor of population mortality from 13 May 2020 to 20 January 2021.

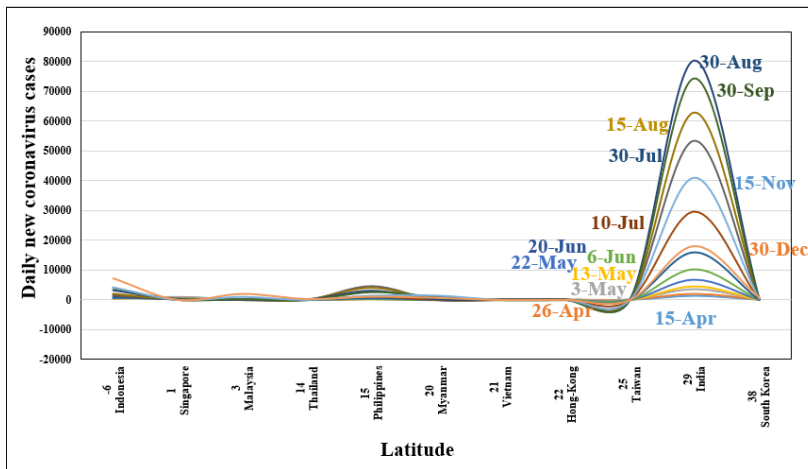


Figure 4: Variation of daily new coronavirus cases from 03 May 2020 to 30 December 2020.

Figure 3 (a) shows the variation of variability factor of population mortality from 13 May to 15 August 2020 with respect to population mortality on 15 April 2020. It shows maximum variations of variability factor of population mortality for India in the Southeast Asian region, whereas other countries show non-significant variations. Figure 3(b) shows sudden rise of variability factor of population mortality for Malaysia, Myanmar, Hong-Kong and Taiwan during 30 September 2020 to 20 January 2021.

The spectrum of daily new covid-19 cases depicted in Figure 4 shows very significant exponential increase for India during July and August 2020, causing significant variability of population mortality. It is observed that daily new covid-19 spectrum for India increased sharply to more than 80,000 daily new cases up to 30 August 2020, prior to decrease sharply to reach less than 20,000 daily new cases during December 2020, whereas sudden increase of daily new cases observed for Indonesia, Malaysia, Thailand and Philippines during the same period, which is responsible for severity of the outbreak.

Figure 5 depicts the variation of population mortality from Covid-19 for 28 countries of the Southeast Asian region that lie between latitudes 64°N and 35°S based on population mortality data from 15 April to 30 August 2020. Population mortality for Southeast Asian region is found relatively lower compared to the countries that lie beyond the latitude 38°N due to adequate sunlight responsible for vitamin-D. Figure 6 shows the variation of variability factor of population mortality from 13 May to 15 August 2020 with respect to population mortality on 15 April 2020. It shows maximum variations of variability factor of population mortality for India and South Africa, whereas other countries shows relatively lower variability factor, due to better healthcare delivery and supply-chain management to control the outbreak.

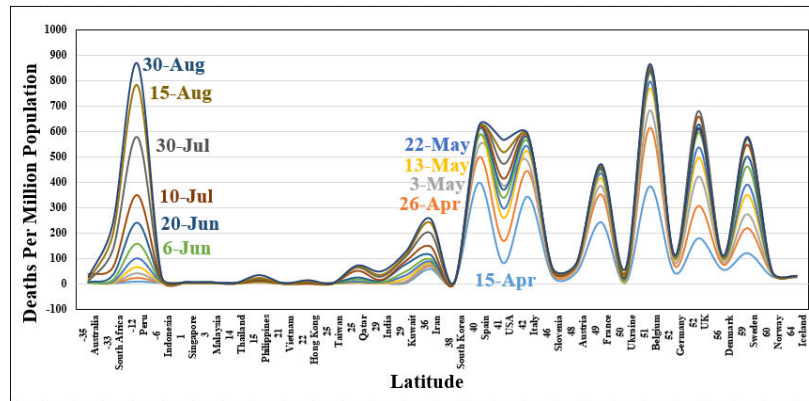


Figure 5: Variation of population mortality of 28 countries from 15 April 2020 to 30 August 2020.

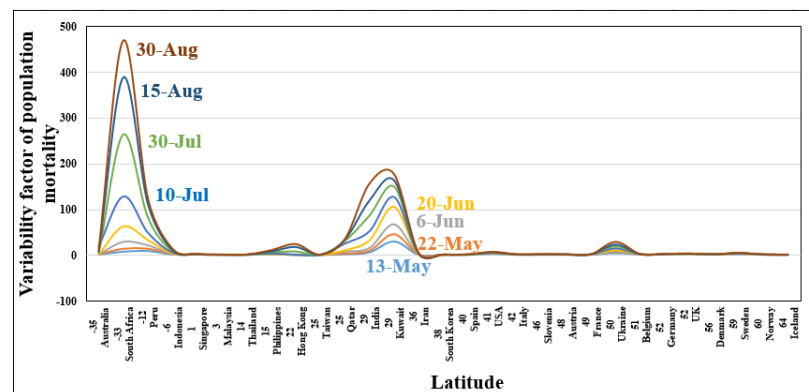


Figure 6: Variation of variability factor of population mortality from 13 May 2020 to 30 August 2020.

4. CONCLUSIONS

This present study describes the first, second, third and fourth peak of the coronavirus spectrum of Southeast Asian region. This present study of spatial big data analysis of population mortality have been carried out for countries that lie between the latitudes 38°N and 6°S based on population mortality data from 15 April 2020 to 20 January 2021. The analysis of the impact of latitude on population mortality from covid-19 shows relatively low population mortality in countries that lie below the latitude 38°N. The sudden rise of variability factor of population mortality for Malaysia, Myanmar, Hong-Kong and Taiwan observed during 30 September 2020 to 20 January 2021 as very significant rise of variability factor and severity of the outbreak, whereas other countries controlled the variability factor for recovery of the outbreak in the Southeast Asian region

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