Analyzing the Impact of Covid-19 on Climatic Condition in Pakistan Using Geospatial Approach

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Abstract

Coronavirus affected the usual trends of environmental factors, globally. This study is an attempt to assess the impacts of COVID-19 on climatic conditions in Pakistan using a geospatial approach. The secondary data is used in this study. For analysis of climatic conditions satellite data of selected climatic factors (wind speed and LST) was collected from openly available websites. The climatic data were downloaded from the MODIS MERRA-2 sensor from EOSDIS Worldview NASA in NC4 File format of wind speed and data of LST from USGS Earth Explorer. The data were processed by using geospatial approaches, such as interpolation (IDW), zonal statistics, and weighted sum. By doing statistical analysis the variations in climatic conditions are assessed. The findings revealed that during the lockdown period variations were observed in climatic conditions due to limitations on anthropogenic and industrial activities. During the lockdown period of the COVID-19 pandemic not only the cases were under control but positive changes in climatic conditions were also observed. During the lockdown period of the pandemic, negative standardized anomalies in LST and wind speed were observed compared to prior years 2018 and 2019. Restriction on anthropogenic activities produces positive changes in environmental conditions.

Keywords: climatic conditions, covid-19, LST, wind speed, lockdown and geospatial approaches.

Introduction

A little cluster of cases of the disease now known as COVID-19 or coronavirus was first detected when a few patients with early symptoms of pneumonia were admitted to hospitals in the Chinese city of Wuhan on December 29, 2019 (Price et al., 2020). Globally WHO (World Health Organization) reported 28,276 confirmed cases with 565 deaths as of February 6, 2020, including at least 25 countries (Wu et al., 2020). Coronavirus was announced as a general public health emergency of International Concern in January 2020 (Bhatnagar et al., 2021) and coronavirus had turned into a global health concern of prime significance, influenced more than

400 million people with 5.7 million confirmed deaths by January 10, 2022 (Praharaj et al., 2022). Coronavirus is a positive single-stranded RNA genome encompassed by an envelope and its diameter ranges from 60nm to 140nm (Singhal, 2020). This disease has expanded expeditiously to the world and poses huge economic, environmental, health, and social challenges to the whole human population (Chakraborty and Maity, 2020).

In Pakistan first case of COVID-19 was reported on February 26, 2020, due to entry of infected pilgrims from Iran (Raza et al., 2021). A constant increase was observed in total cases of coronavirus until 12th June. 273,113 total confirmed cases were reported until 25th July 2020 (Ahsan-ul-Haq et al., 2022). The mortality rate was low in Pakistan as compared to other countries like Italy, Iran, Spain, and the USA (Amin et al., 2020). The spread of this pandemic can only be controlled by taking preventive measures. Pakistan imposed its first lockdown after three weeks since the first case reported when the total number of cases was greater than 880 (Farooq et al., 2020). The government of Pakistan did not impose a complete lockdown precipitously around the country but instead imposed it systematically (Khan et al., 2021). In Pakistan, the first lockdown was imposed on 23rd of March 2020, within the province of Sind, accompanied by a nationwide lockdown from 25th March, 2020. However, the lockdown policy varied from sector to sector such as the residential and industrial sectors. Therefore, divided the lockdown period into different stages, P1 the earlier stage from January to February, P2 before the lockdown period from the 1st of March to the 22nd of March 2020, P3 lockdown period from the 23rd of March to the 15th of April 2020, P4 loosed lockdown period from 16th of April to 30th of April 2020 and P5 selected lockdown period from 1st of May to 15th of May 2020. P4 refers to a partial or loose lockdown period when industries were not operating (Ali et al., 2021).

The association between coronavirus and climatic factors was ambiguous, which was demonstrated by both positive and negative impacts (Amnuaylojaroen et al., 2021). The positive environmental variations were reported because of the lockdown period during the COVID-19 pandemic (Evangeliou et al., 2021). COVID-19 had many positive impacts on air pollution and climatic conditions. A decrease in anthropogenic activities led to a significant decline in air pollution (Khan et al., 2021). The lockdowns during the COVID-19 pandemic brought larger changes in land surface temperature between rural and urban areas due to a reduction in anthropogenic activities (Sahani et al., 2021). The anomalies in land surface temperature during the lockdown period of COVID-19 were first studied over the worst virus-affected areas of North America and Europe. The studies discovered huge negative changes in night-time land surface

temperature in Europe (0.11°C to -2.6°C) also significant changes were observed in both day and night time LST across North America from March to May in the pandemic year 2020 contrasted to the average of years before pandemic from 2015 to 2019, which can be partly due to the effects of lockdown period during COVID-19. The reduction in LST was associated with a negative change in air temperature (-0.46°C to -0.96°C). On the other side, the increase in daytime LST was observed throughout most regions of Europe due to a decrease in solar radiation by barometrical aerosols. The negative changes in LST at night time may be associated with reduced anthropogenic activities. In North America, studies discovered a significant negative change in LST of both day and night time during the lockdown period (Parida et al., 2021).

The changes in wind speed are mainly due to land use and land cover changes (Navinya et al., 2020). An increasing trend was observed in wind speed during the pandemic between 10th March 2020 and 21st July 2020. After that time period, a decline was observed in wind speed. In Pakistan, fluctuations were observed in wind speed from 10th March 2020 to 04th October 2020 (Ali et al., 2021). The overarching goals of this research are to analyze changes in LST and wind speed during the lockdowns of the pandemic by using satellite data. However, the present study is based on previous literature and elucidates the impact of COVID-19 on climatic factors across the Pakistan and also helps to interpret the significant changes in climatic factors during the lockdown period and the reasons behind these significant changes in the study area by using geospatial approaches.

Study Area

The study area named Pakistan is located in the western zone of South Asia geographically extends from 30°22'31.2" N latitudes. It denotes Pakistan's location in the Northern Hemisphere and ranges from 69°20.707' E longitudes which represent the eastern location of Pakistan (Salma et al., 2012). Pakistan is comprised of four provinces Punjab, Sindh, Baluchistan, and KPK, and Islamabad Capital Territory. Additionally, there are two other administrative states Azad Jammu Kashmir (AJK) and Gilgit Baltistan as shown in Figure **1**. Pakistan is a land of mountains, plains, deserts, and coastal belt. The area of Pakistan is 796,095 square kilometers (Mohsin, 2020). Pakistan enjoys a wide range of seasons. Pakistan lies in the temperate zone, above the tropic of cancer. Pakistan has a bimodal distribution of rainfall. Pakistan is a developing country with a fragile health system and the financial condition of

Pakistan is also not better, the impacts of the virus were more in Pakistan as compared to developed countries. The potential risk of COVID-19 risk was more in Pakistan because of Pakistan's Population dynamics and demographics (Noreen et al., 2020). This study also analyzes the impacts of the COVID-19 pandemic on the climatic factors of Pakistan and helps to create a pandemic overview in Pakistan.

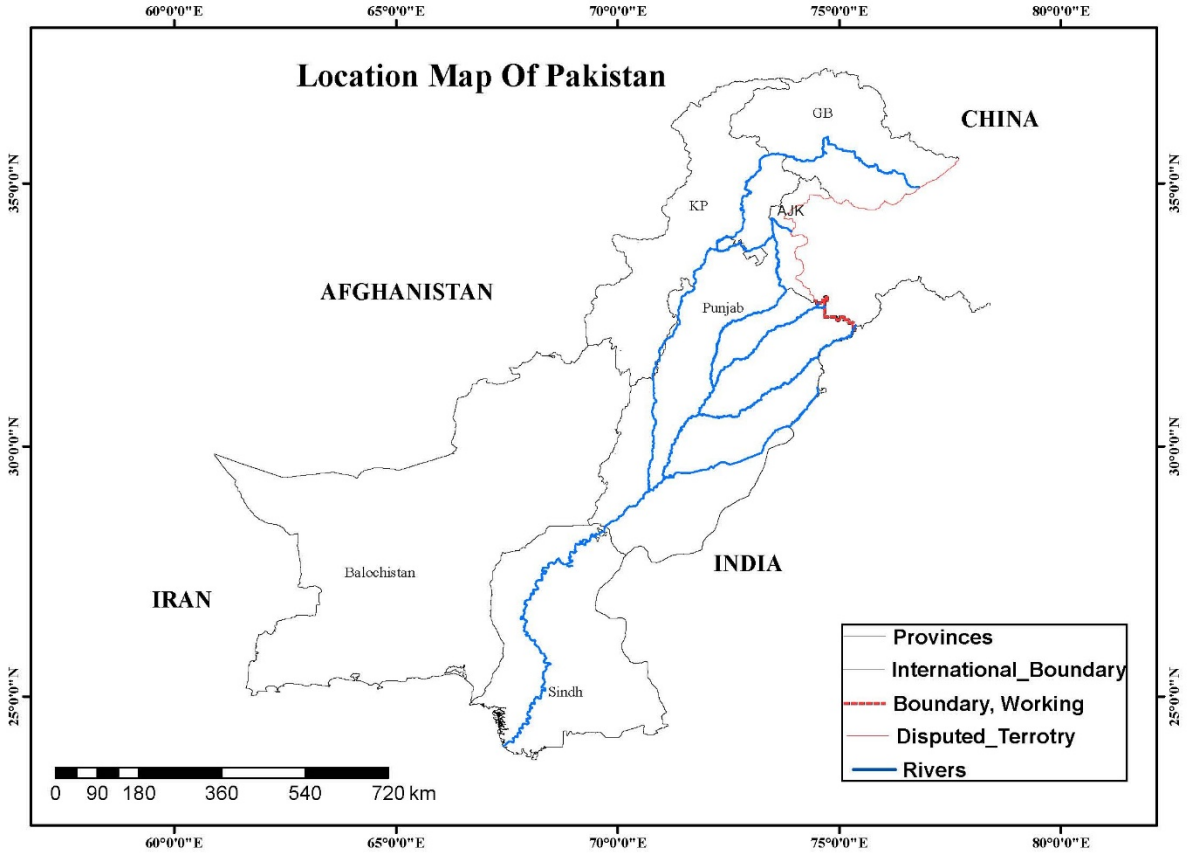

Figure 1: Study Area Map of Pakistan

Datasets used

To achieve the objectives of this study secondary data sources were exploited. For this study, satellite data and COVID-19 data were used. The data was collected through remote sources. Data has been downloaded manually from different websites. The monthly data of selected environmental factors (LST and wind speed) was downloaded from January 2018 to March 2022 and of preceding years 2018 and 2019 of pandemic and during COVID-19 pandemic. This data was collected from satellites images namely MODIS MERRA-2 sensor from EOSDIS Worldview NASA in NC4 file format of wind speed and data of LST from USGS

Earth Explorer to analyze the changes in environmental condition. In this study, the satellites images of climatic data of Pakistan were downloaded of preceding years 2018 and 2019 as a proxy for conditions and compared them with data for the period 2020, 2021 and 2022 under lockdown conditions. And province wise COVID-19 monthly data set of total cases assembled from open source website covid.gov.pk from March 2020 to March 2022 of COVID-19 this time period was considered for statistical data analysis because the first case of COVID-19 in Pakistan was reported on 26th February 2020. Table **1, 2 and 3** summarized the COVID-19 data which was used in this research and collected from open source website covid.gov.pk.

Table 1: Monthly COVID-19 data of Total Cases

COVID-19 Total Cases 2020							
Months	ICT	Punjab	Sindh	KPK	Baluchistan	Gilgit Baltistan	AJK
March	54	708	0	253	158	184	6
April	343	6340	6053	2627	1049	339	66
May	2589	26240	28245	10027	4393	711	255
June	12912	76262	84640	26598	10476	1489	1093
July	150333	93057	121039	34056	11743	2134	2084
August	15649	96832	129469	36118	12879	2903	2299
September	16611	99479	137106	37811	15281	3787	2731
October	19970	104271	145851	39564	15920	4261	4133
November	30406	119578	174350	47370	17187	4658	6933
December	37888	138608	215679	58701	18168	4857	8277

Table 2: Monthly COVID-19 Total Cases of 2021

COVID-19 Total Cases 2021							
Months	ICT	Punjab	Sindh	KPK	Baluchistan	Gilgit Baltistan	AJK
January	41418	157796	247249	67214	18823	4909	9019
February	44373	172054	258266	72424	19049	4956	10243
March	58557	223181	265680	88099	19576	5033	12805
April	75498	303182	283560	118413	22369	5310	17187
May	81257	340110	318579	132822	25218	5588	19250
June	82706	346301	337674	138068	27178	6138	20343
July	87699	356920	382865	144264	30432	8156	24501
August	99516	394738	432637	162402	32248	9919	32228
September	105516	431666	457928	174017	32926	10328	34157
October	106921	440259	470175	178074	33263	10390	34478
November	107722	443185	475820	180075	33484	10412	34556
December	108666	445107	482029	181402	33638	10429	34662

Table 3: Monthly COVID-19 Total Cases of 2022

COVID-19 Total Cases 2022							
Months	ICT	Punjab	Sindh	KPK	Baluchistan	Gilgit Baltistan	AJK
January	128429	480421	543170	194887	34417	10703	38339
February	134404	501544	568277	216174	35345	11499	42978
March	135072	505003	575257	219026	35472	11702	43261

The data of wind speed (m/s) was extracted from MEERA-2 2d_lfo_Nx which is monthly mean data collection and for Land Surface Temperature (Kelvin) (LST) data collected from USGS Earth Explorer in HDF format. For the conversion of radiance Kelvin values to LST, first digital number (DN) obtained from USGS of the image were calculated and their average was taken out and multiplied with 0.02 and then radiance was subtracted from 273.15 (Javid et al., 2019). The data has been prepared by using the ArcGIS 10.3.1 software and MS Excel. The COVID-19 data was analyzed by using Microsoft Excel Spreadsheet and presented in the form of tables. The COVID-19 and climatic data both were processed by using Arc GIS. After that Inverse Distance Weighted (IDW) was used for visualization and to show the trends of COVID-19 data and variations of climatic factors. IDW is type of deterministic method of interpolation that estimates cell values by averaging the value of given sample data points in the neighborhood of each processing cell. Finally, zonal statistic implemented to show districts wise visualization of both COVID-19 and climatic data. Furthermore, maps were produced to show spatial distribution across Pakistan by using Arc Map Tools. The weighted sum analysis approach provides the ability to weight and combine series of raster inputs to create an integrated analysis. The weighted sum multiplies all the input raster values by specified weight. Statistical Analysis was performed to show changes in environmental factors at district level of Pakistan. By using this method, a generalized visualization of variation in climatic conditions in areas of Pakistan due to COVID-19 is shown.

Results

In this research impacts of the COVID-19 pandemic on climatic conditions are assessed and also how the lockdown period during the pandemic caused variations in environmental conditions. In this study it has already been mentioned cause of this pandemic, preventive measures were taken such as wearing masks, social distancing, limiting transport, closure of industries, and lockdowns were imposed to control the spread of COVID-19, lockdowns not only minimized the spread of COVID-19 but also brought positive changes in environmental conditions. In this study analysis are performed at both level district and province level. Tables represent impacts of lockdown on environmental conditions at district-level and images across the country. In Pakistan the first lockdown was imposed in the month of March 2020 to June 2020 known as strict lockdown. In the month of July 2020, the government again imposed a

partial lockdown. In May 2021 the government again imposed a lockdown known as Eid lockdown. By June 2021 COVID-19 had hit Pakistan hard. Until March 2022 the most affected province by coronavirus was Sindh with 575257 total reported cases. And the least affected was GB with 11702 total cases. The total cases in March 2022 were 251334. The lockdown not only controlled the spread of COVID-19 cases but also caused changes in climatic conditions. Figure 2 depicts how during strict lockdown the cases of COVID-19 were under control. When the government loosened the lockdown, an increasing trend was observed in total cases in different parts of the country. Figure 3 **Error! Reference source not found.**shows how COVID-19 during the partial lockdown affected the country. Figure 4 depicts how COVID-19 affected Pakistan after the month of October 2020. Similarly, Figure 6 and 7 show the terrible increase in COVID-19 cases. And Figure 8 presents how pitifully coronavirus affected the Pakistan till March 2022.

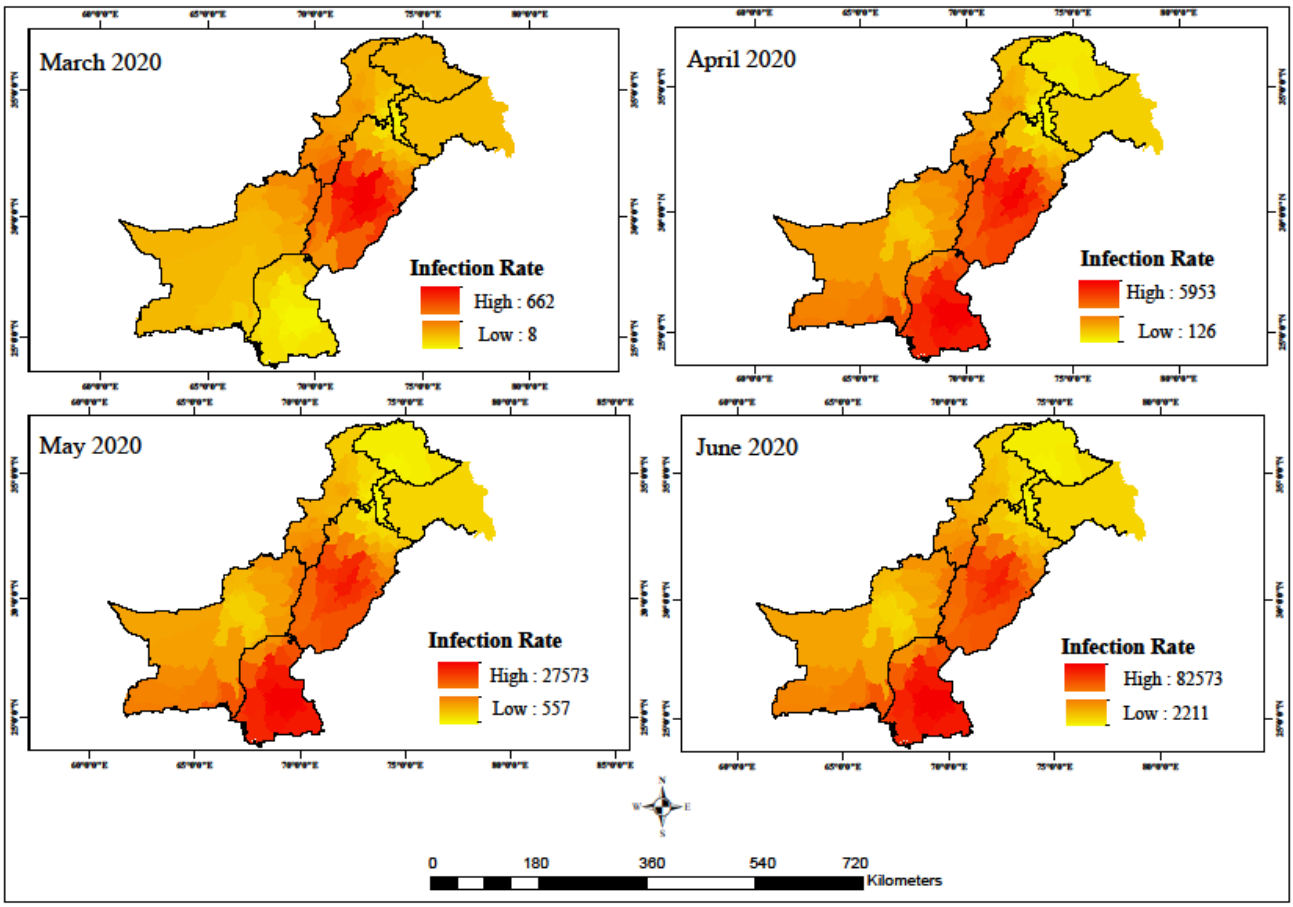

Figure 2: Spatial Distribution of Total Cases of Covid-19 during Strict Lockdown Period

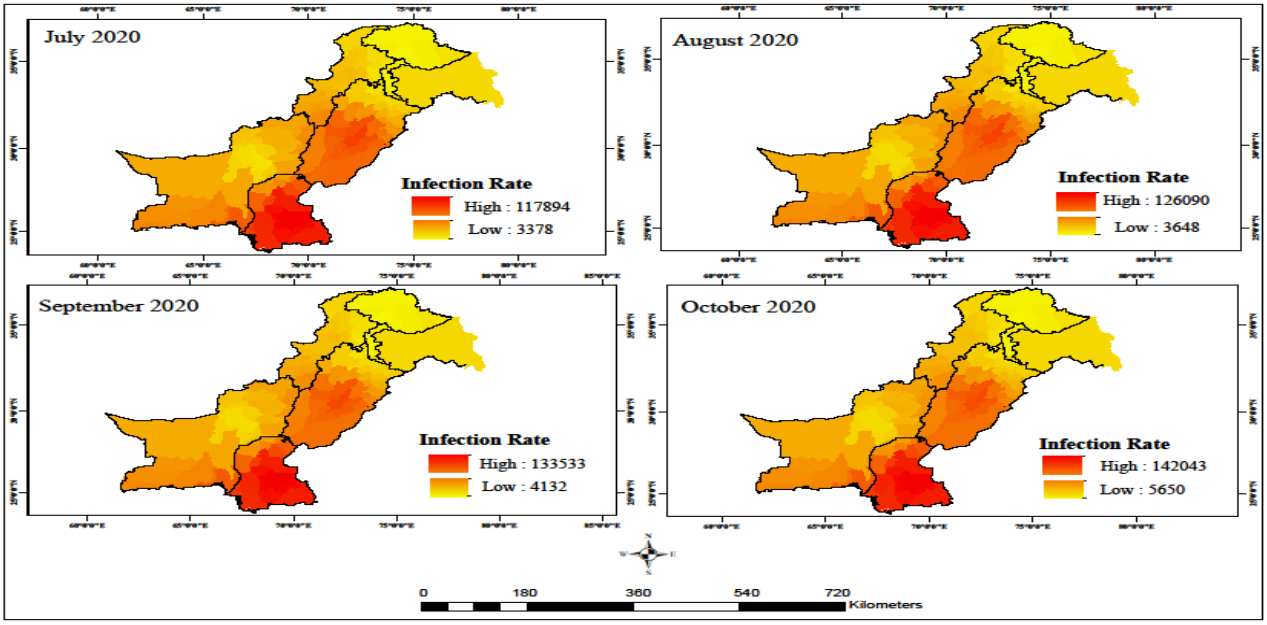

Figure 3: Spatial Distribution of Total Cases of Covid-19 during Partial Lockdown Period

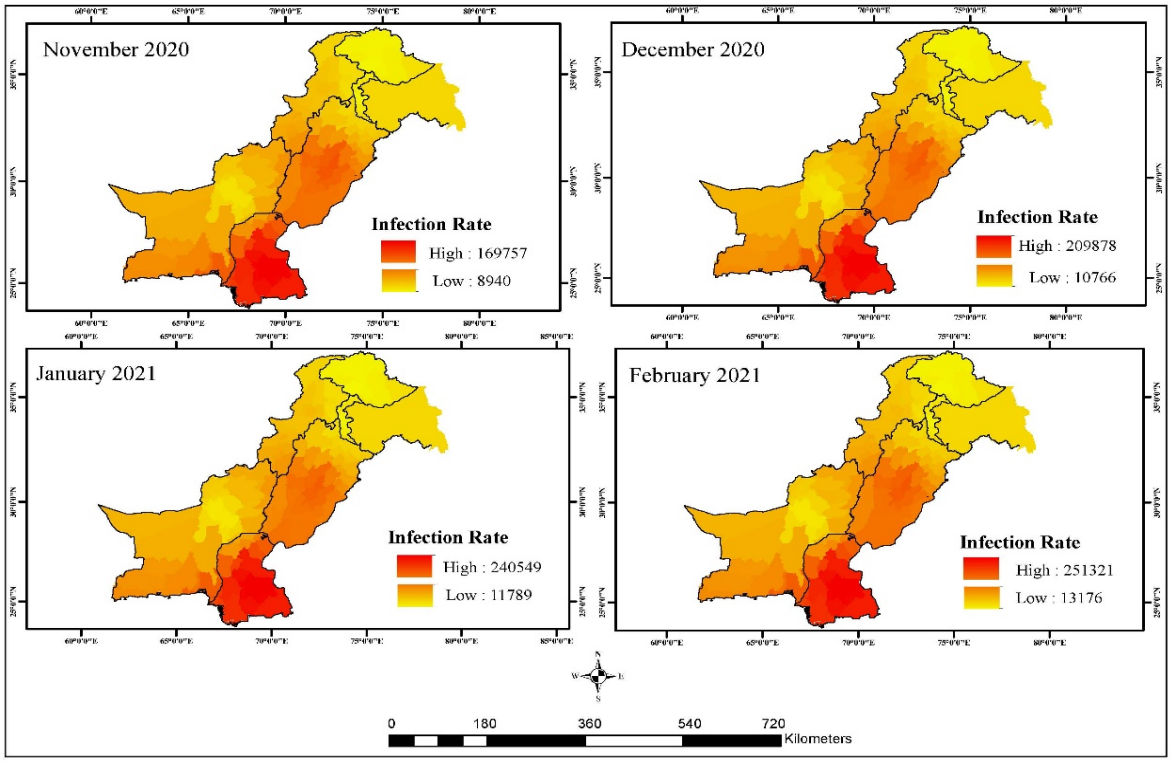

Figure 4: Spatial Distributions of Total Cases of Covid-19 after Lockdown Period

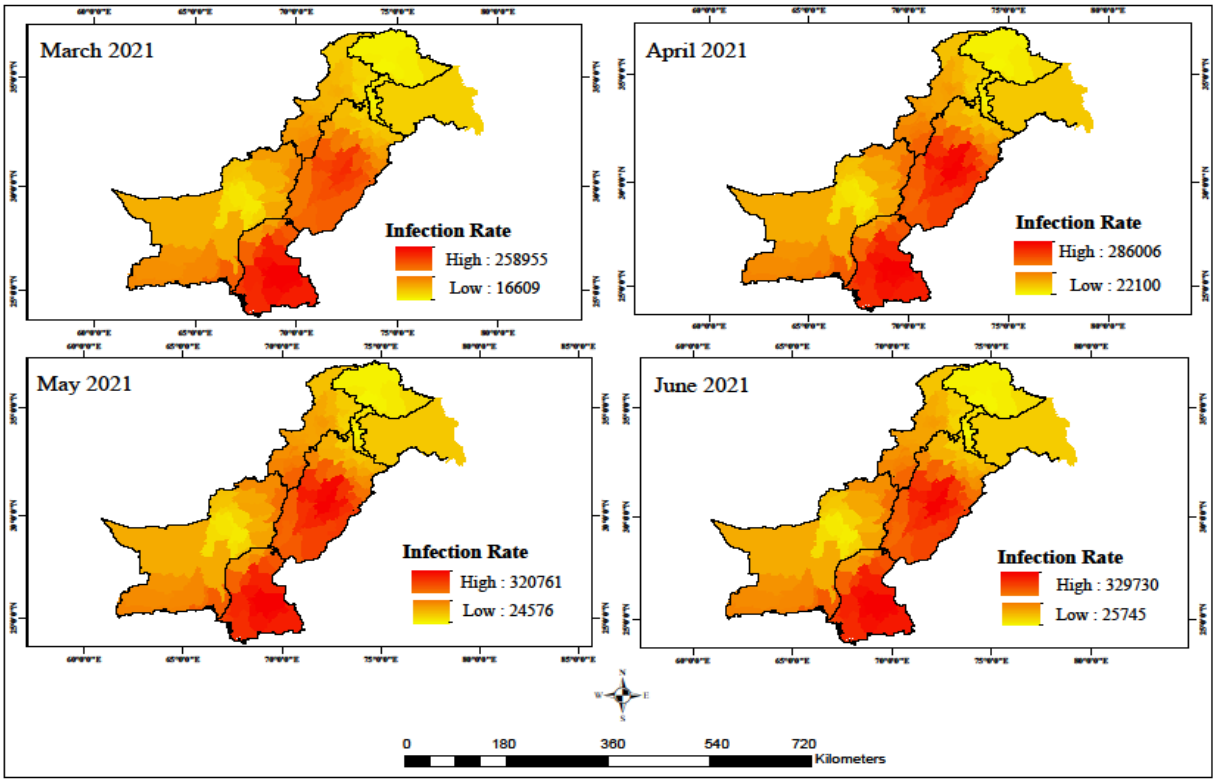

Figure 5: Spatial Distribution of Total Cases of Covid-19

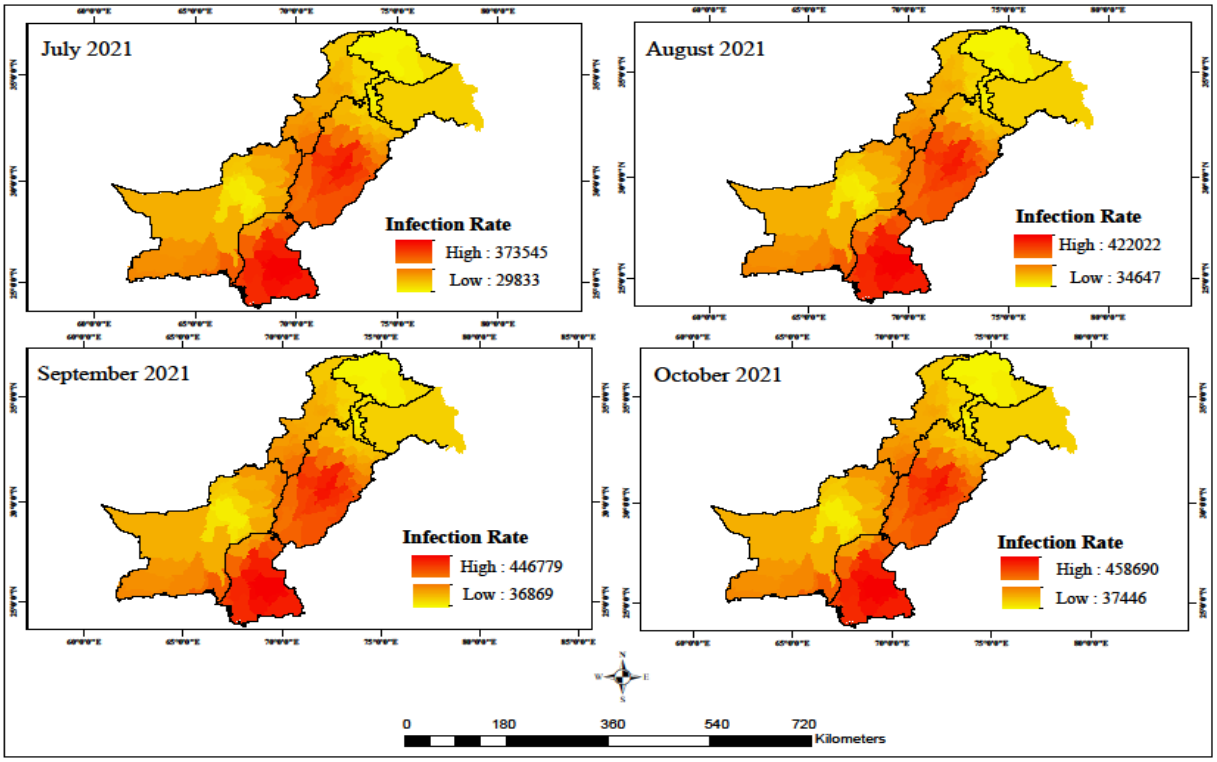

Figure 6: Spatial Distribution of Total Cases of Covid-19

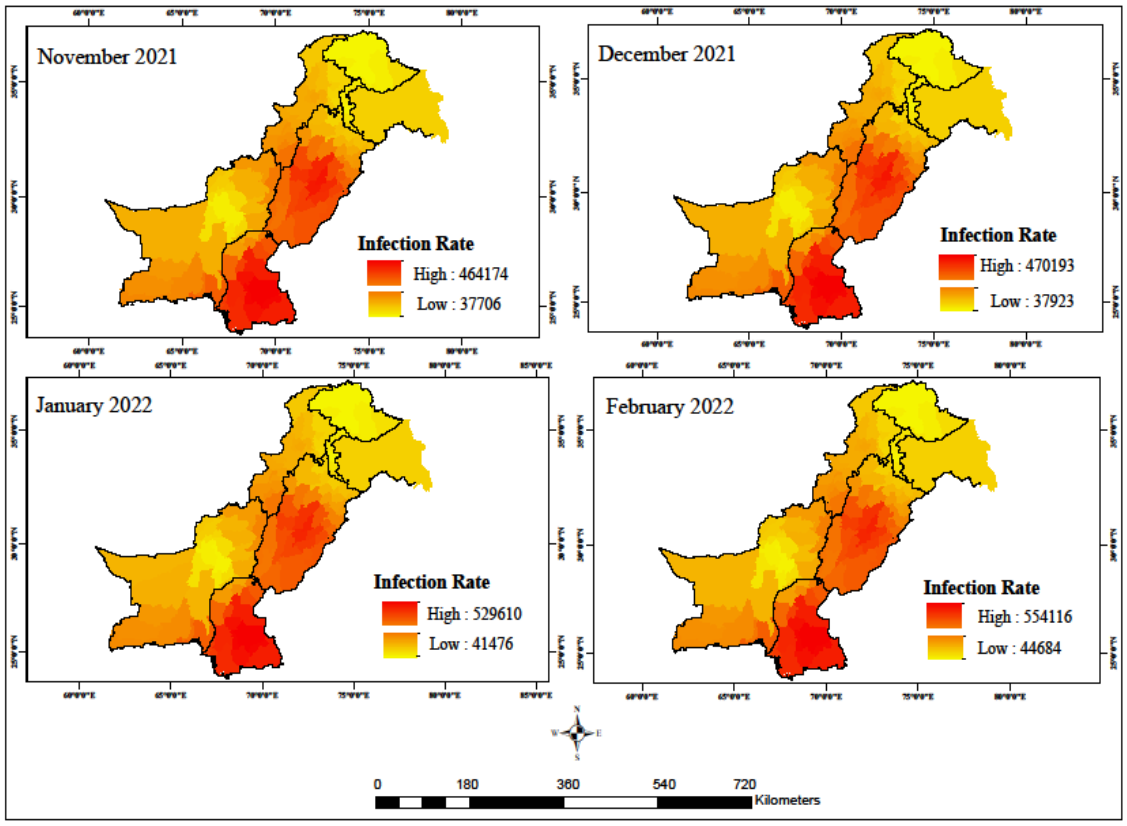

Figure 7: Spatial Distribution of Total Cases of Covid-19

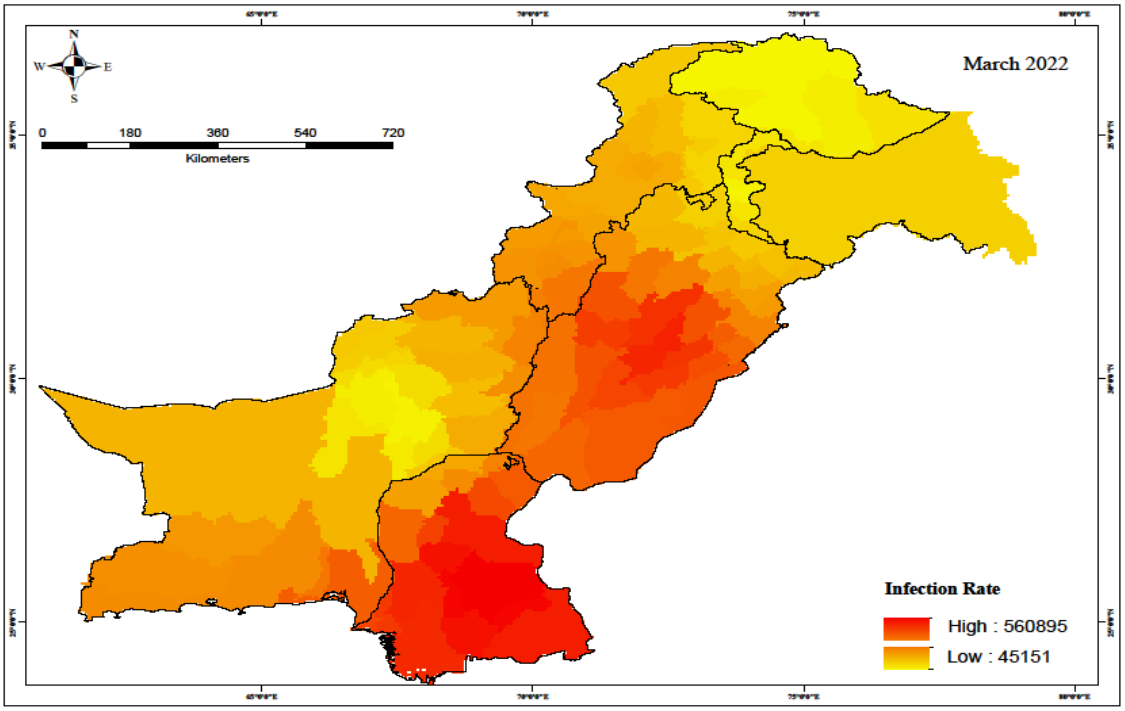

Figure 8: Spatial Distribution of Total Cases of Covid-19

A substantial variation in climatic factors was observed over Pakistan during the lockdown period. The results show a clear distinction between climatic factors before and after the lockdown period over the country. In the COVID-19 pandemic during the lockdown period decreasing trend was observed in the monthly district-wise mean of wind speed. In March 2020, the monthly average wind speed decreased to 4.23m/s from 4.38m/s and 4.36m/s compared to March 2018 and March 2019 respectively. A similar trend was also observed during the lockdown period of April 2020. There was a decline in the monthly district-wise average wind speed from 4.66m/s in April 2018 and 4.55m/s in April 2019 to 4.28m/s in April 2020. Figure 9 and 10 represent the spatial distribution of wind speed before the lockdown in March and April 2018 and 2019. Figure 11 shows the spatial distribution of wind speed during the lockdown period of March and April 2020. The monthly district-wise mean wind speed decreased. In May 2020 wind speed was 4.85m/s which decreased from 4.97m/s and 4.91m/s respectively prior to the years 2018 and 2019. Figure 16 shows the spatial distribution of wind speed during the lockdown period of May 2020 and Figure 14 and15 portray the spatial distribution of wind speed before the lockdown period of May 2018 and 2019. In June 2020, the wind speed also decreased due to lockdown from 5.26m/s in June 2018 and 5.14m/s in June 2019 to 4.58 m/s in June 2020. A similar trend was also observed during the 2021 lockdown in the month of May 2021.

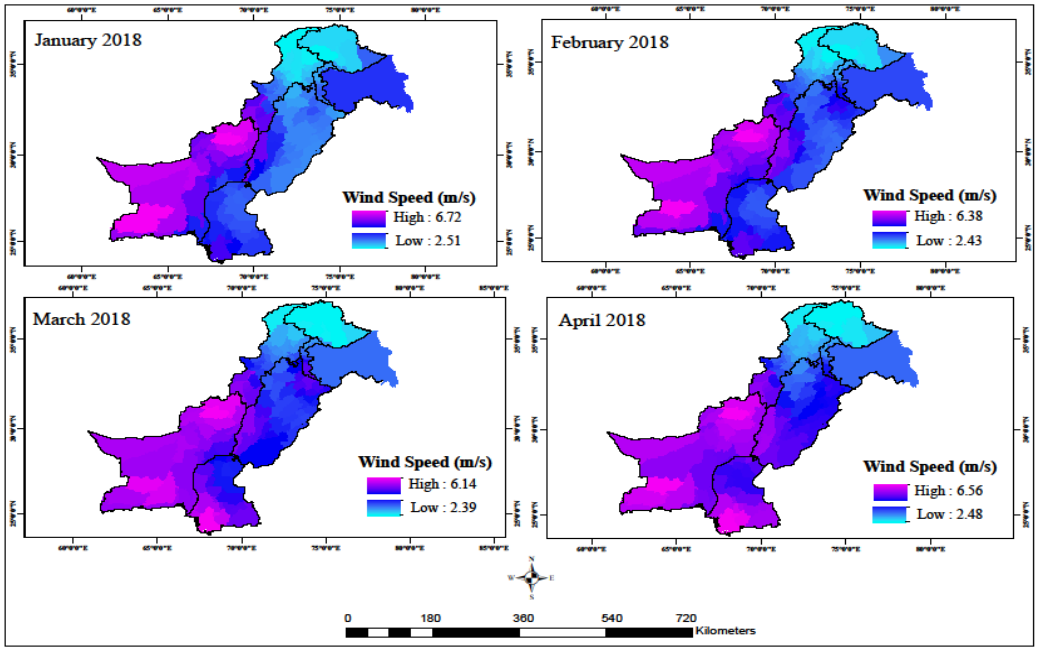

Figure 9: Spatial Distribution of Wind Speed in 2018 before Covid-19 Pandemic

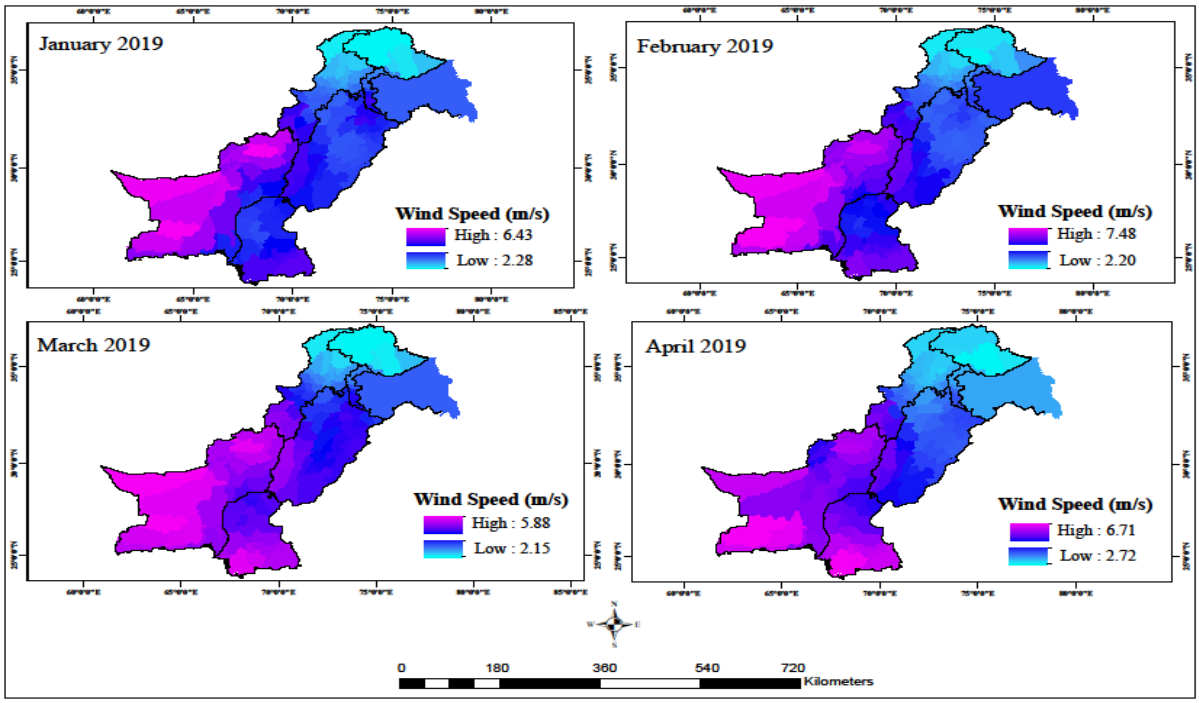

Figure 10: Spatial Distribution of Wind Speed in 2019 before Covid-19 Pandemic

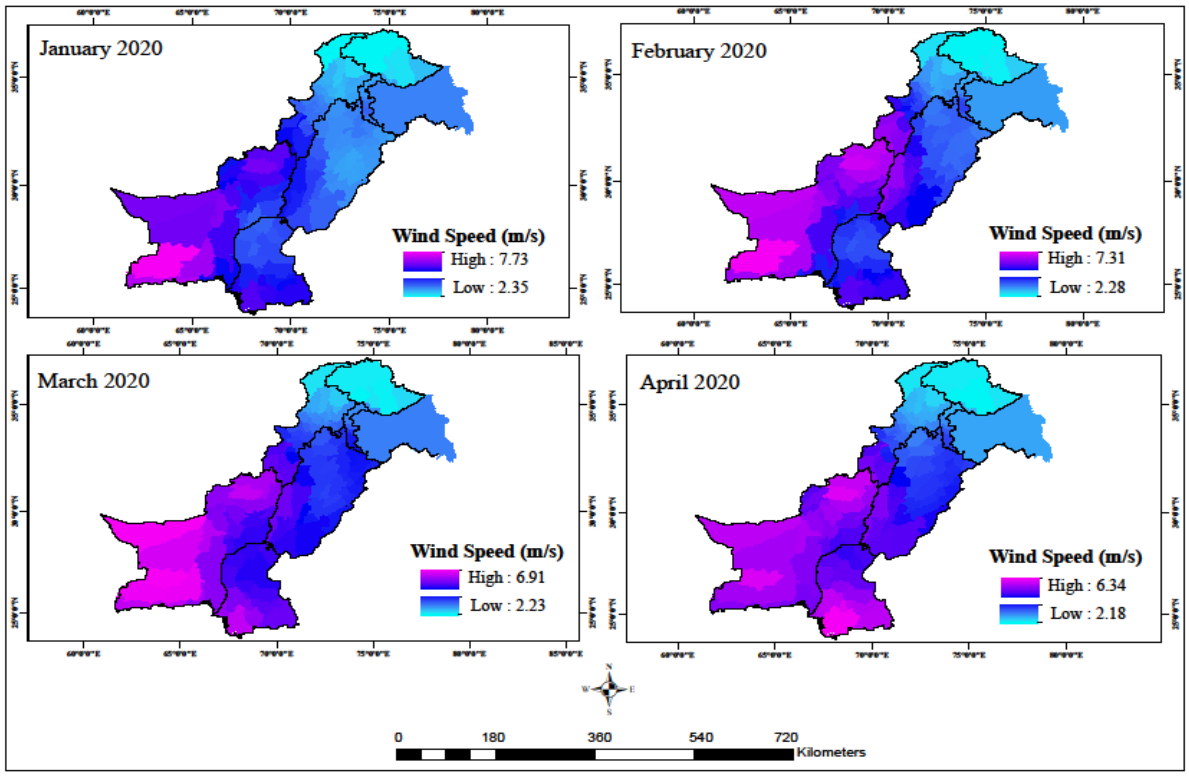

Figure 11: Spatial Distribution of Wind Speed during Pandemic 2020

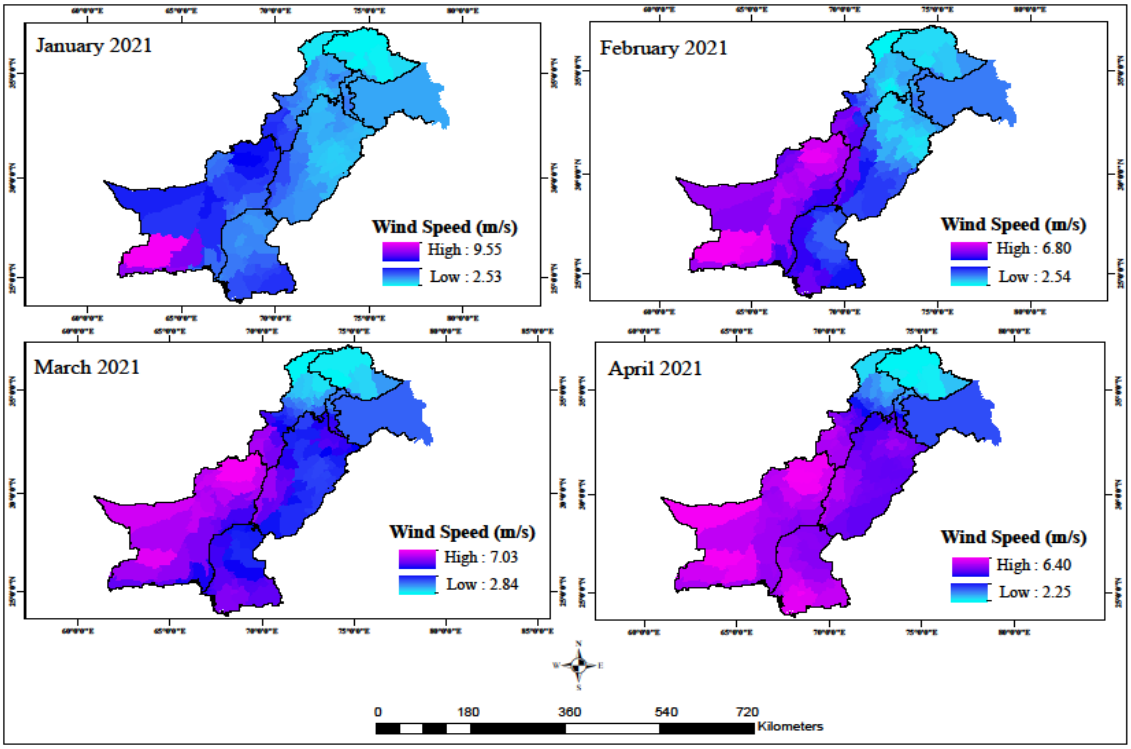

Figure 12: Spatial Distribution of Wind Speed during Pandemic 2021

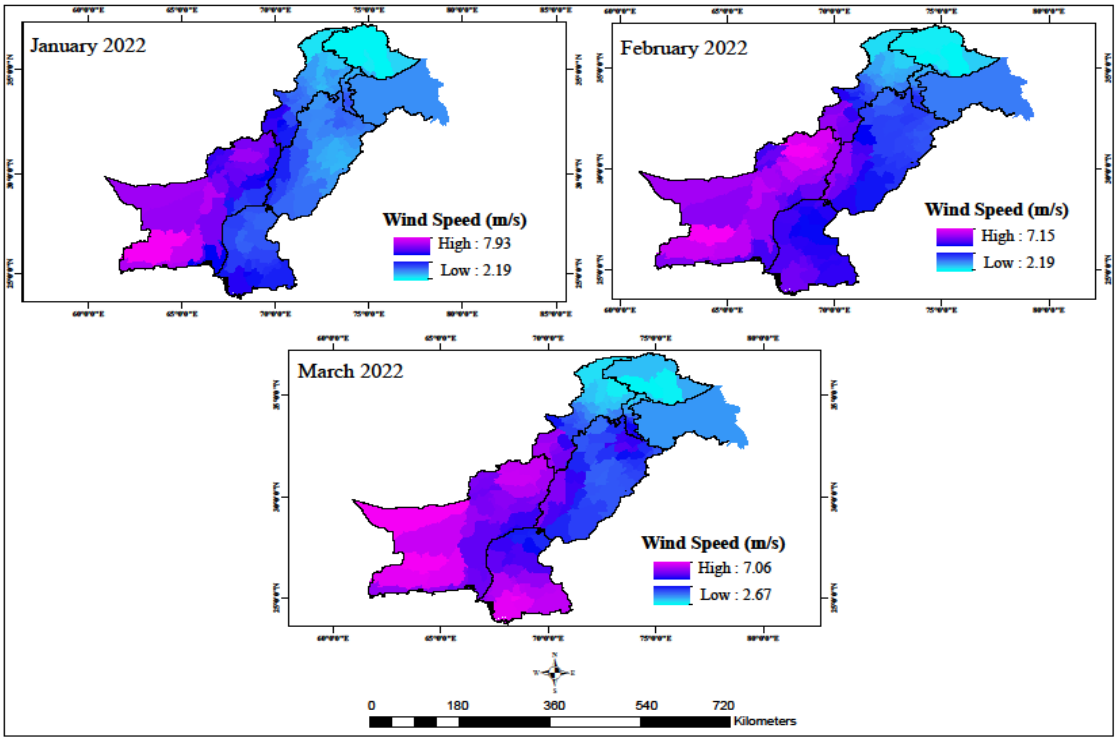

Figure 13: Spatial Distribution of Wind Speed during Covid-19 Pandemic 2022

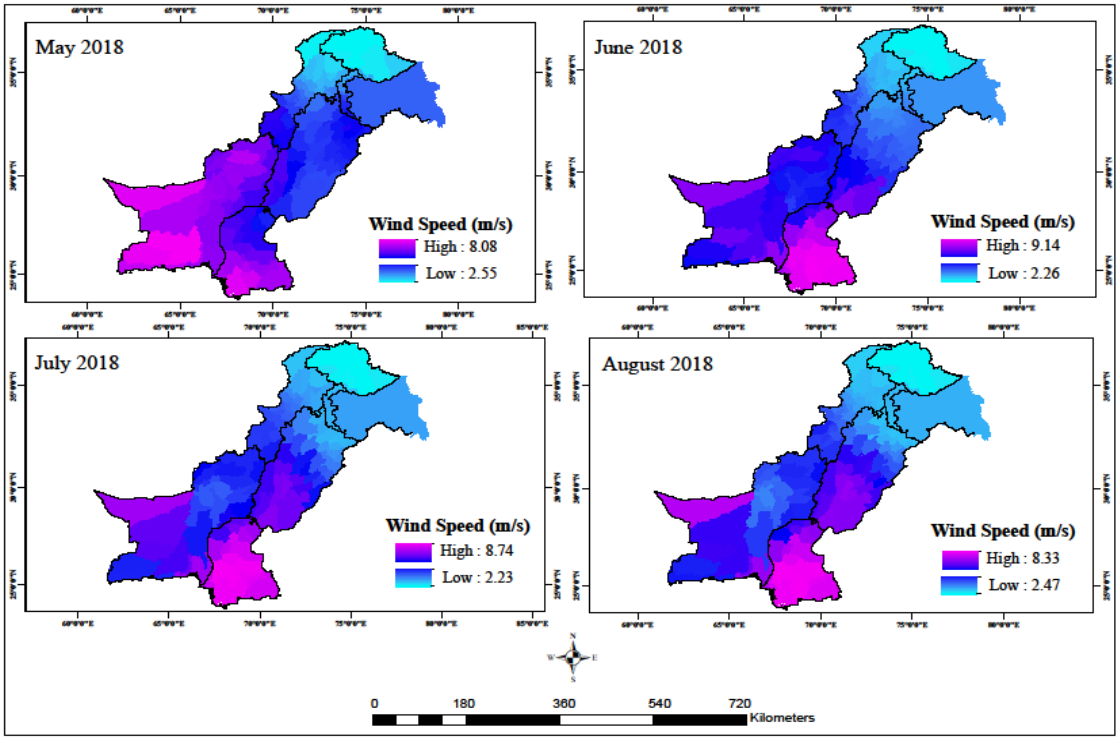

Figure 14: Spatial Distribution of Wind Speed 2018 before Covid-19 Pandemic

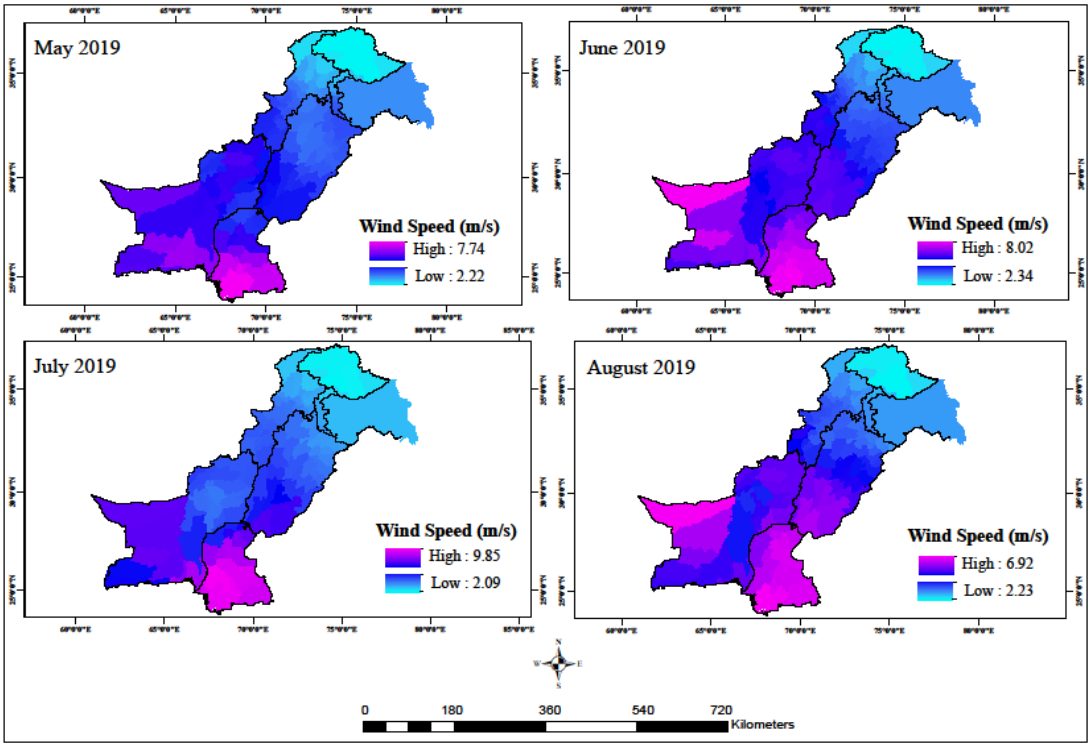

Figure 15: Spatial Distribution of Wind Speed 2019 before Covid-19 Pandemic

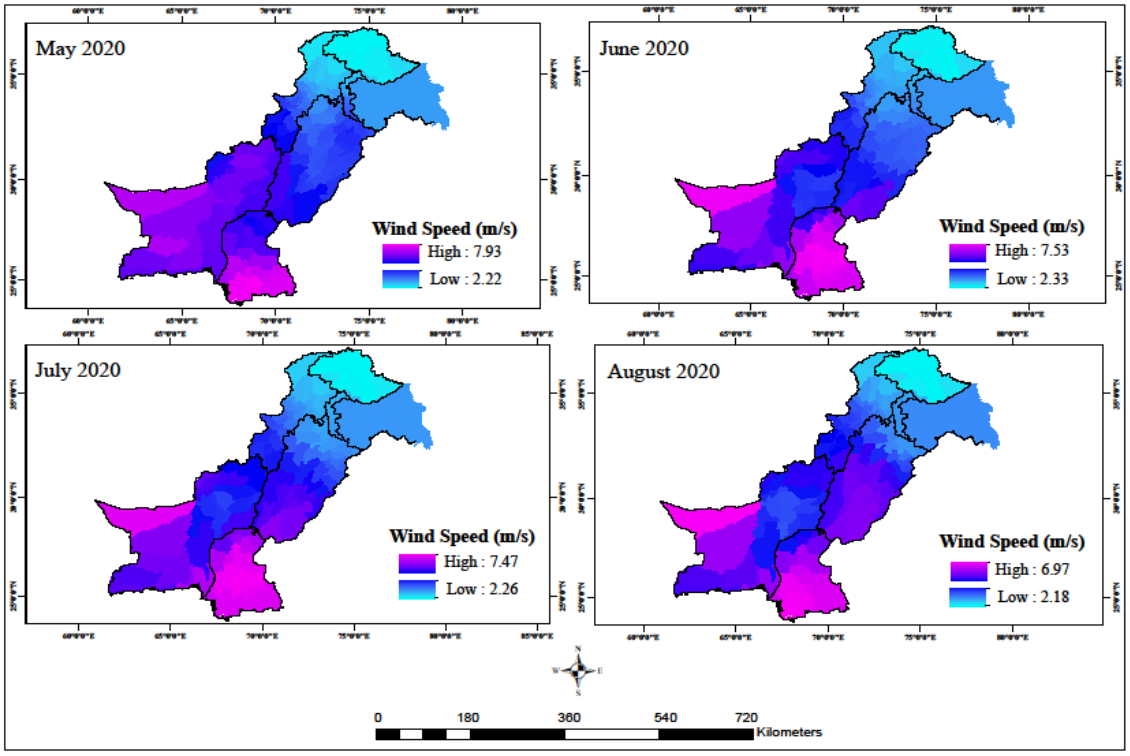

Figure 16 Spatial Distribution of Wind Speed 2020 During Covid-19 Pandemic

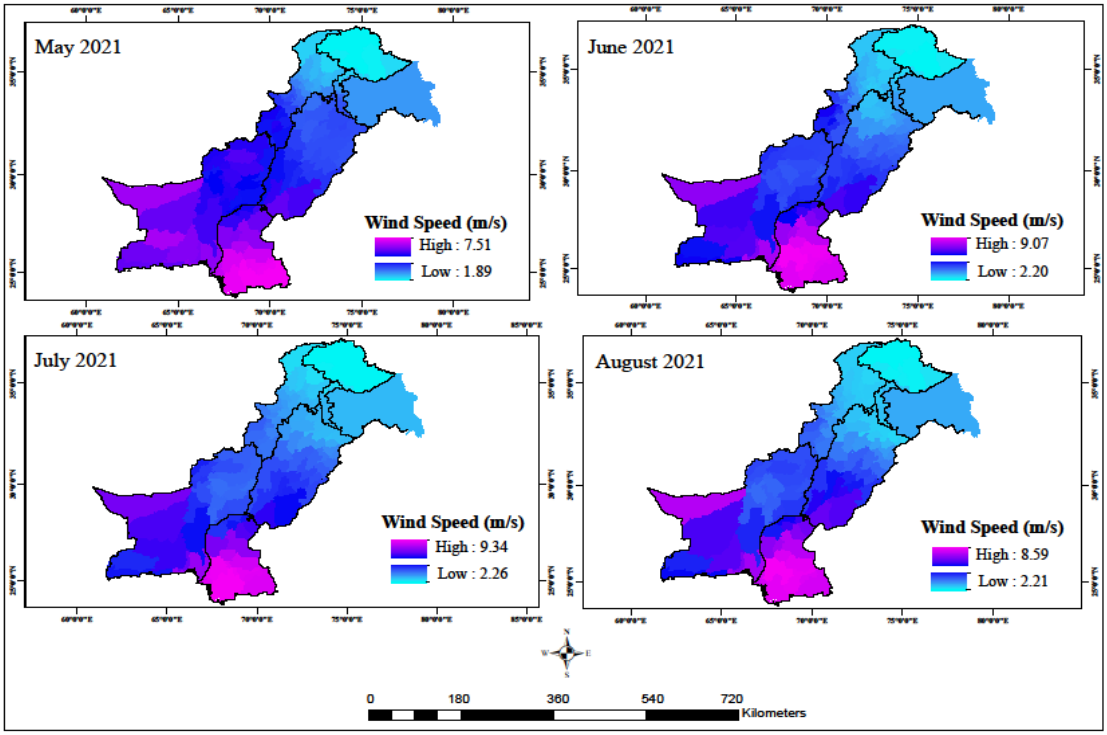

Figure 17: Spatial Distribution of Wind Speed 2021 during Covid-19 Pandemic

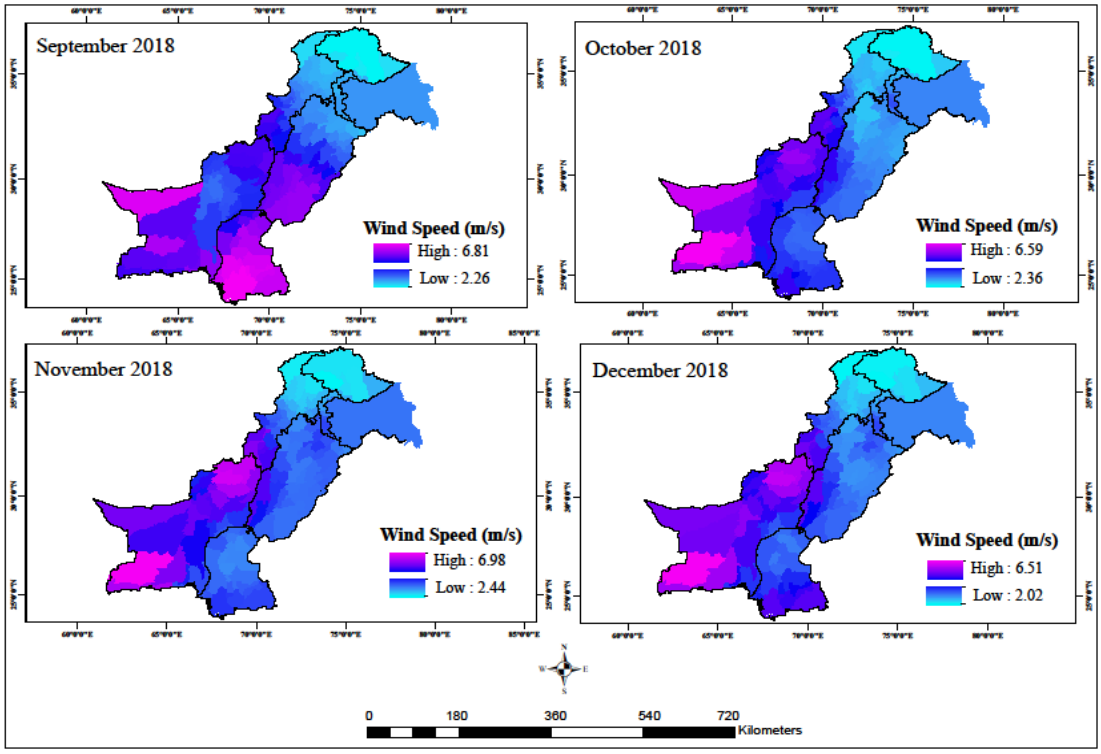

Figure 18: Spatial Distribution of Wind Speed 2018 Before Covid-19 Pandemic

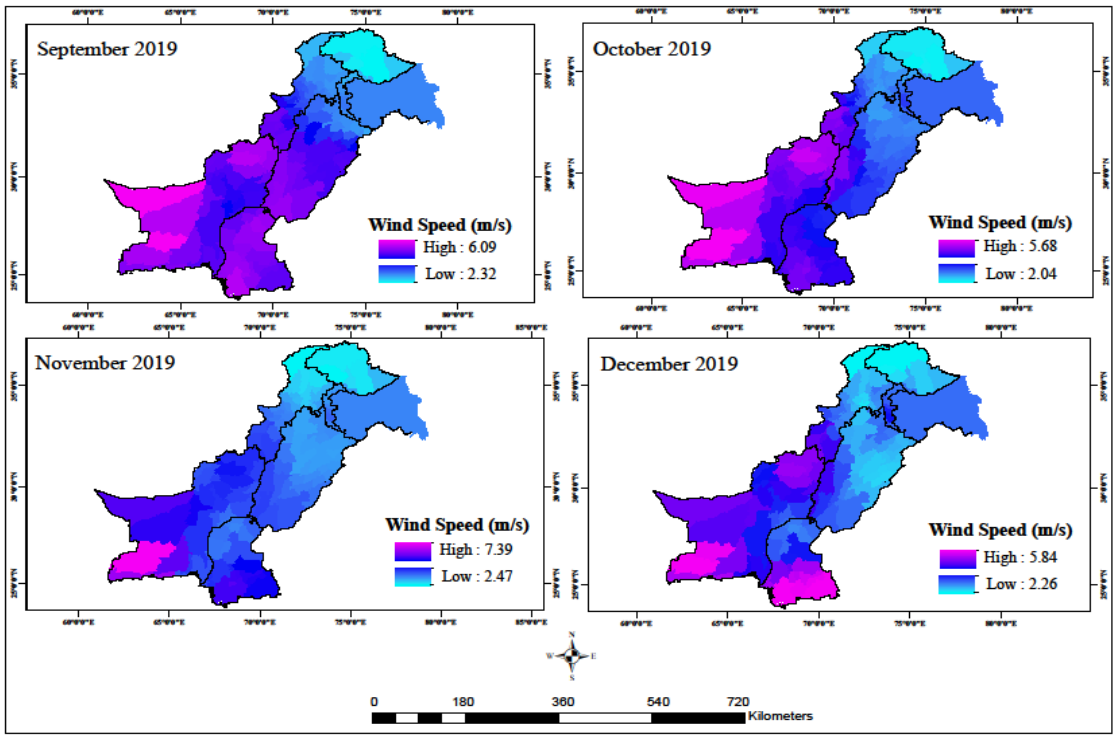

Figure 19: Spatial Distribution of Wind Speed 2019 before Covid-19 Pandemic

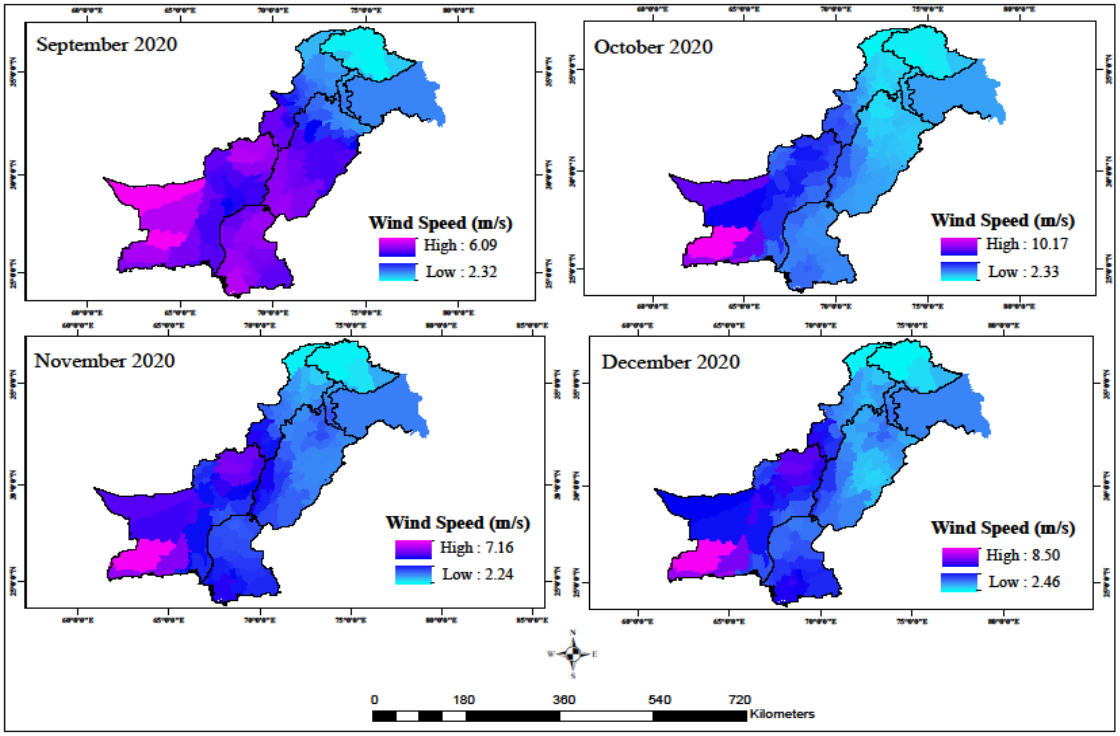

Figure 20: Spatial Distribution of Wind Speed 2020 during Covid-19 Pandemic

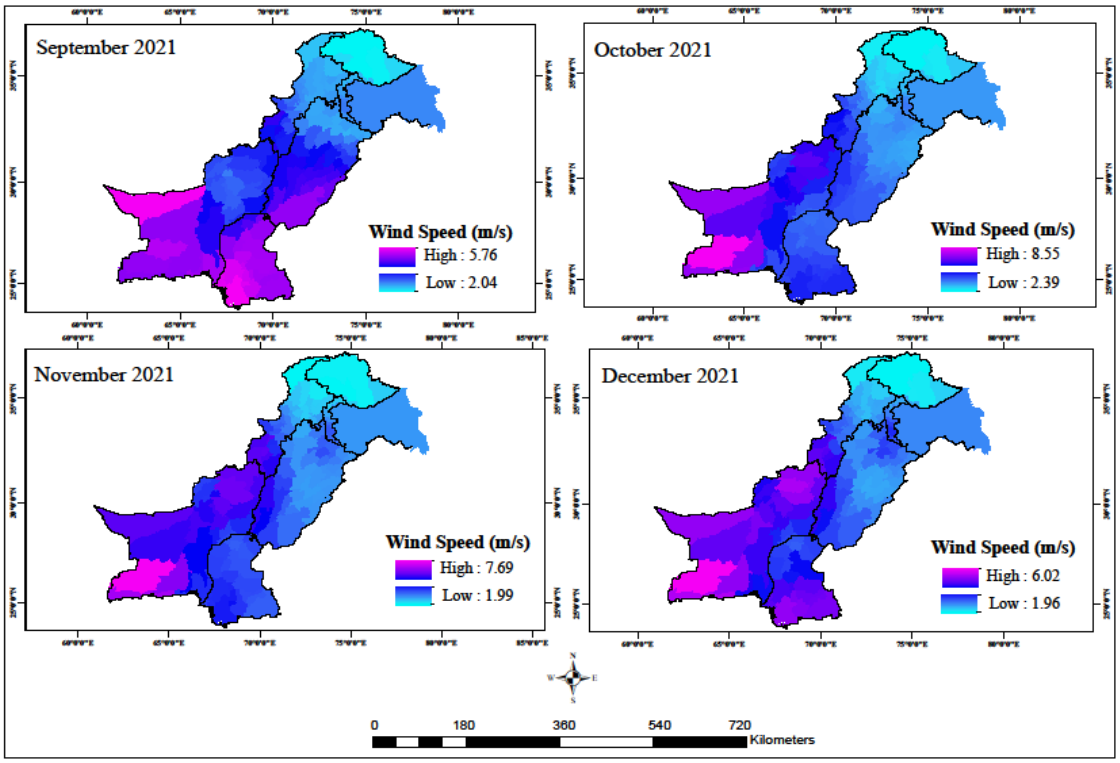

Figure 21: Spatial Distribution of Wind Speed 2021 during Covid-19 Pandemic

Table 4 : Statistics of Wind Speed During Lockdown

Wind Speed (m/s)	2018	2019	2020	2021
March	4.38	4.36	4.23	4.86
April	4.66	4.55	4.28	4.76
May	4.97	4.91	4.85	4.52
June	5.26	5.14	4.58	4.91

Figure 14 and 15 show wind speed distribution before the lockdown period of May 2018 and 2019. The monthly district-wise mean wind speed decreased in May 2021 (decreased to 4.52m/s May 2021 from 4.97m/s in May 2018 and 4.91m/s in May 2019. Figure 17 depicts the spatial variation of wind speed during the lockdown period of May 2021. After June 2020 again contrasting variation was observed in the values of wind speed this was because of the loosening of the lockdown. From the obtained results variations in wind speed were very clear during the lockdown period. Figure 9, 10, 14, 15 18 and 19 depict the spatial distribution of wind speed before the COVID-19 pandemic of 2018 and 2019 respectively. Figure 11, 12 16, 17, 20 and 21 show the spatial distribution of wind speed during the COVID-19 pandemic 2020 and 2021, sequentially. Similarly, Figure 13 shows wind speed district-wise distribution during the COVID-19 pandemic from January to March 2022. During the pandemic years 2020 and 2021 the annual average wind speed increased compared to the previous year 2019. Table 4 represents district–wise average of wind speed during the lockdown period of the pandemic.

The reduction in LST during the lockdown period was observed over Pakistan. The results of this study revealed that a 5°C reduction in the district-wise average of LST over Pakistan was observed in the month of March 2020 against the month of March 2018 (from 28°C in 2018 to 23°C in 2020) and as compared to the March 2019 the decline was 1°C (from 24°C in 2019 to 23°C in 2020). Figure shows the spatial distribution of LST over the country during the lockdown of March 2020 compared to 2018 and 2019 March before the lockdown period in Figure 22 and 23 respectively. The decline in LST was also observed in the month of April 2020. Figure 24 portrays the distribution of LST during the lockdown period of April 2020. The month of April 2020 showed a 2°C negative anomaly in LST against April 2018 (from 33°C in 2018 to 31°C in 2020) and as compared to the 2019 the decline was 1°C (from 32°C in 2019 to 31°C in 2020). Figure 22 and 23 depict the spatial distribution of LST before lockdown in April 2018 and 2019 sequentially. The decline in LST was also noticed in the month of May 2020 and LST had

shown a negative anomaly of 1°C compared to the May of 2018 and 2019 (from 38°C to 37°C in both years 2018 and 2019). Figure 29 depicts the spatial distribution of LST during the lockdown period of May and June 2020. Figure 27 and 28 depict the distribution of LST before the lockdown period of May and June of 2018 and 2019 respectively. A decrease in the month of June 2020 was also noticed. The LST decreased 1°C in June 2020 compared to previous years 2018 and 2019 (from 38°C in June 2018 to 37°C in June 2020 and similarly in June 2019 from 38°C to 37°C). The same pattern was also remarked for LST in the month of May 2021 because of the lockdown and LST had shown a negative anomaly of 1°C as compared to 2018 and 2019 (from 38°C to 37°C in both years 2018 and 2019). Figure 30 shows the spatial distribution of LST during the lockdown period of May 2021. The drop in LST could be associated with lockdown or generally cooler weather. After the month of June 2020, we again started to observe the increase in LST because of the loosening of the lockdown that increased the anthropogenic activities. Figure 22, 23, 27, 28 31 and 32 depict the spatial distribution of LST before the COVID-19 pandemic period.

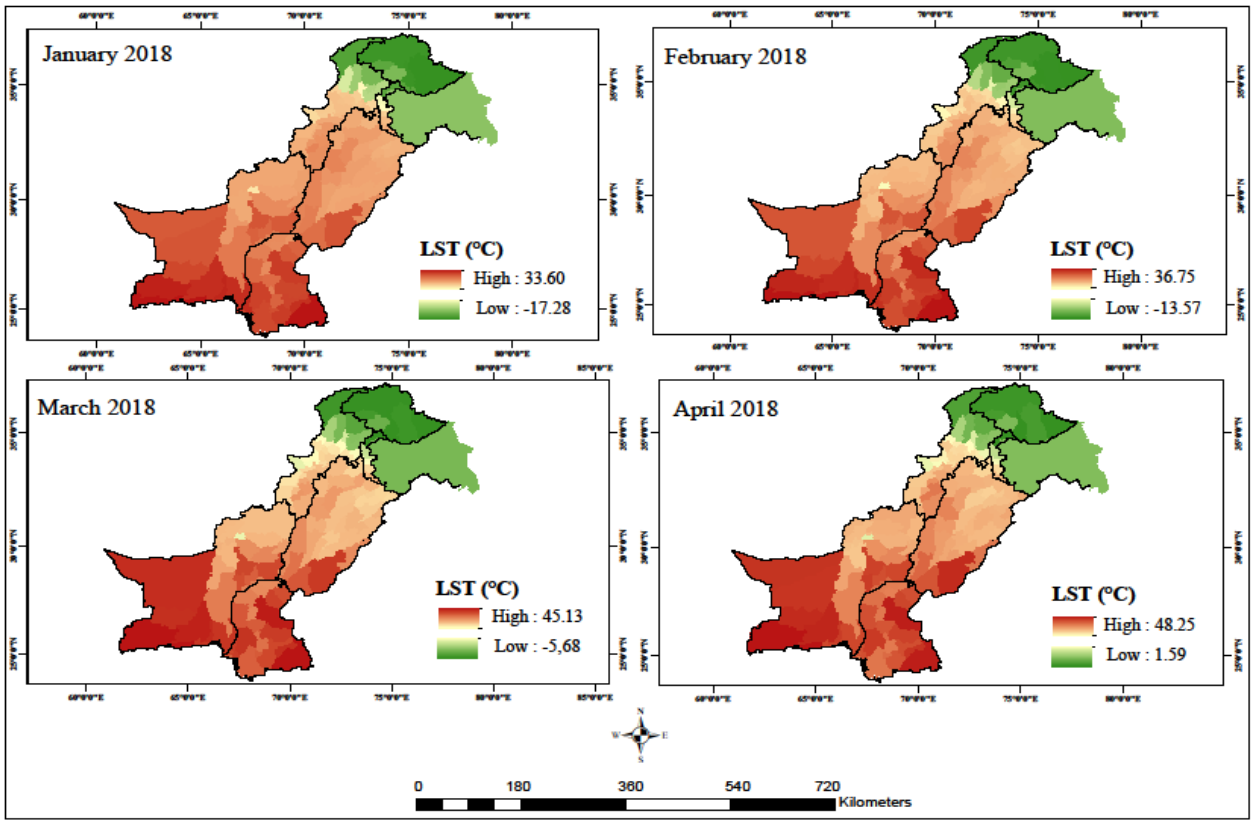

Figure 22: Spatial Distribution of LST before Covid-19 Pandemic 2018

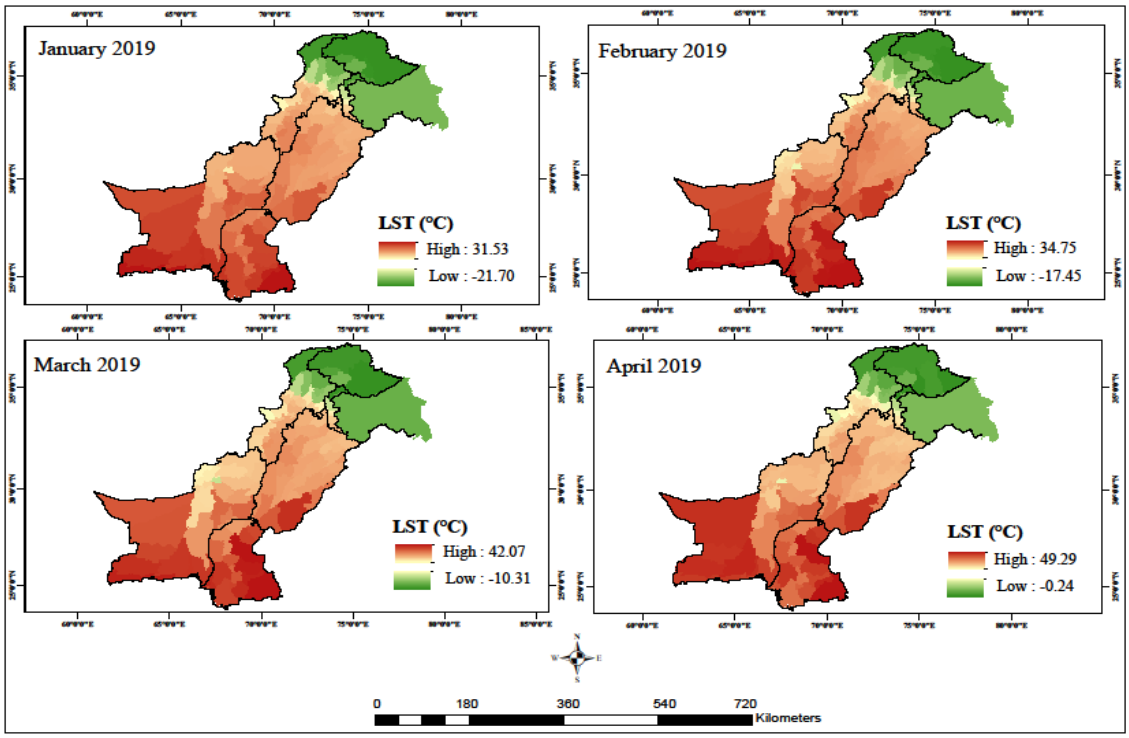

Figure 23: Spatial Distribution of LST Before Covid-19 Pandemic 2019

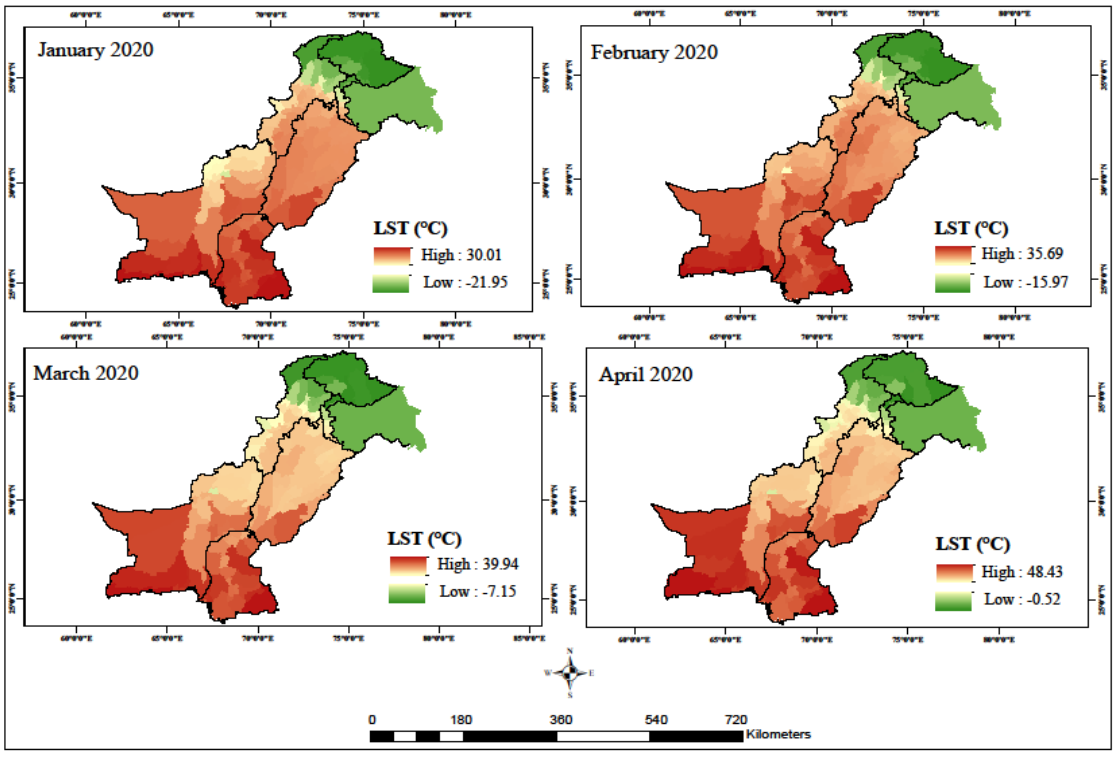

Figure 24: Spatial Distribution of LST During Covid-19 Pandemic 2020

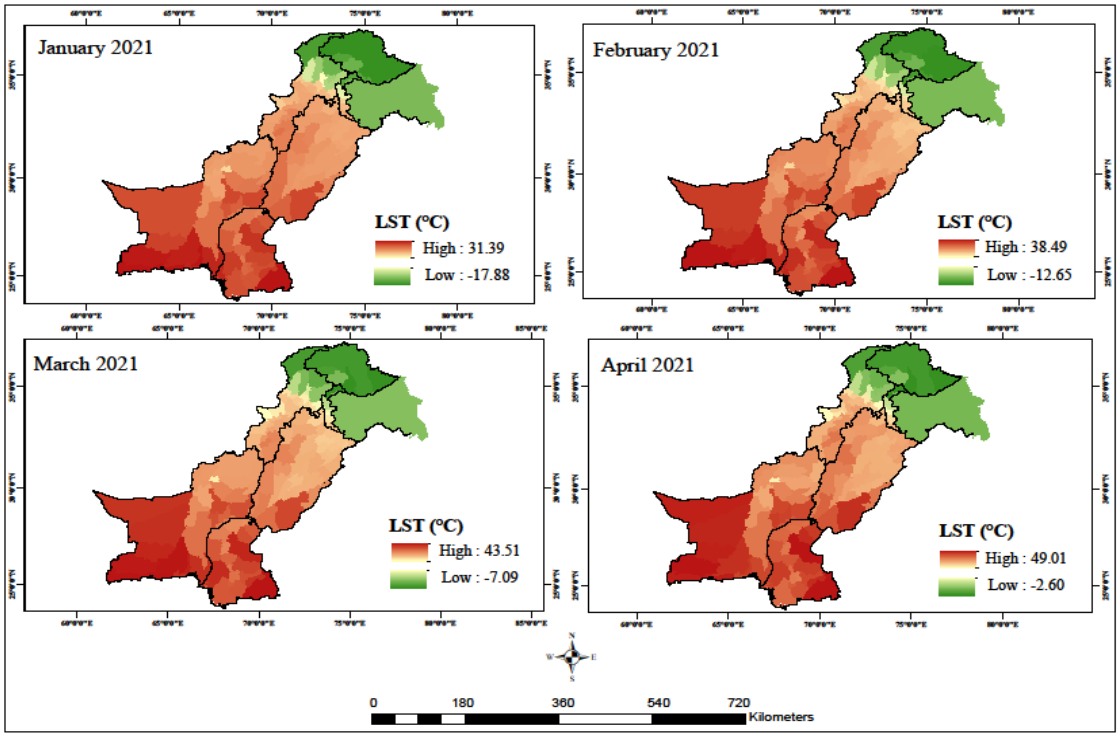

Figure 25: Spatial Distribution of LST During Covid-19 Pandemic 2021

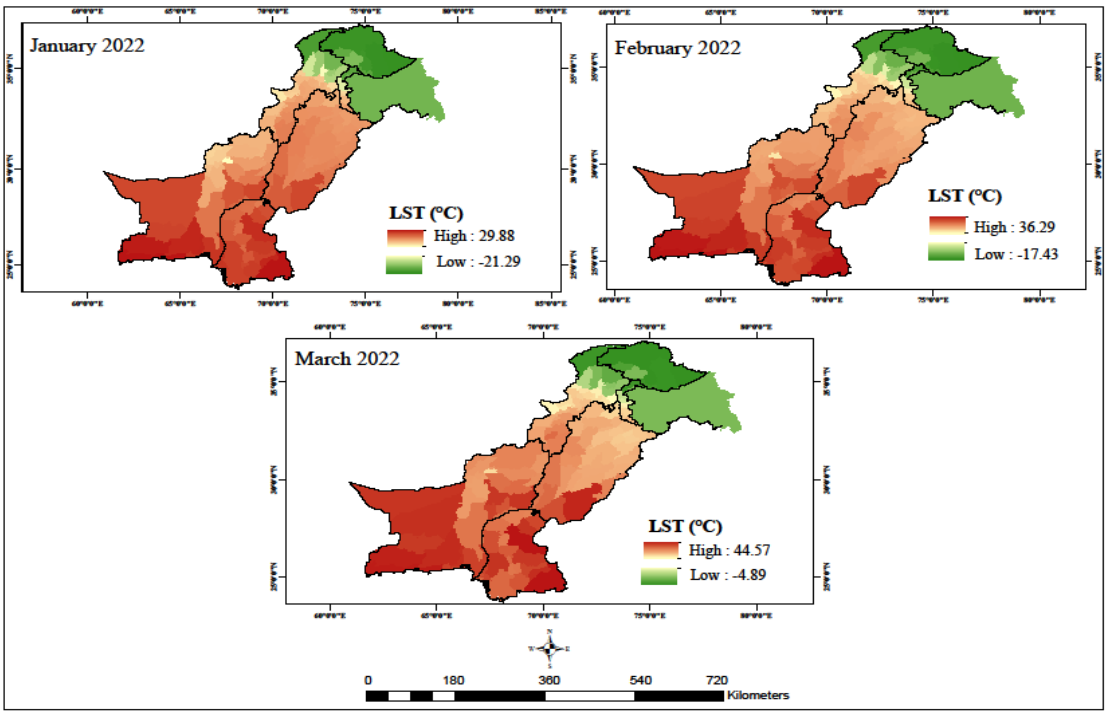

Figure 26: Spatial Distribution of LST During Covid-19 Pandemic 2022

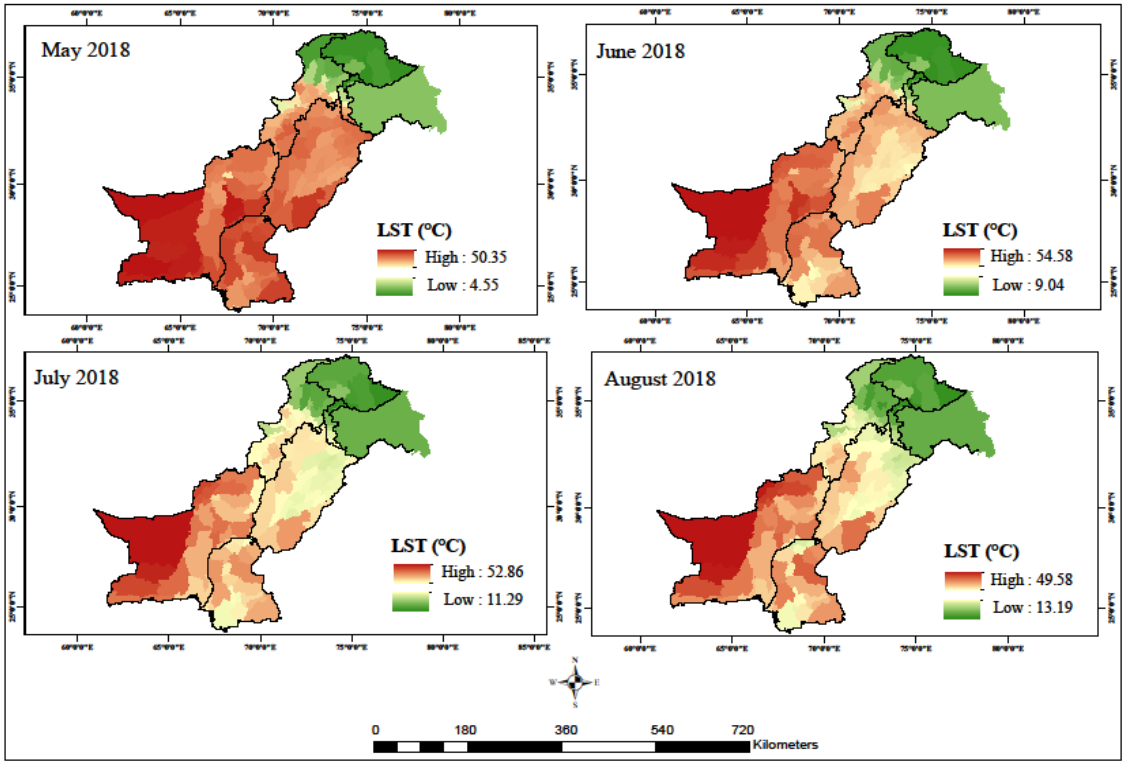

Figure 27: Spatial Distribution of LST Before Covid-19 Pandemic 2018

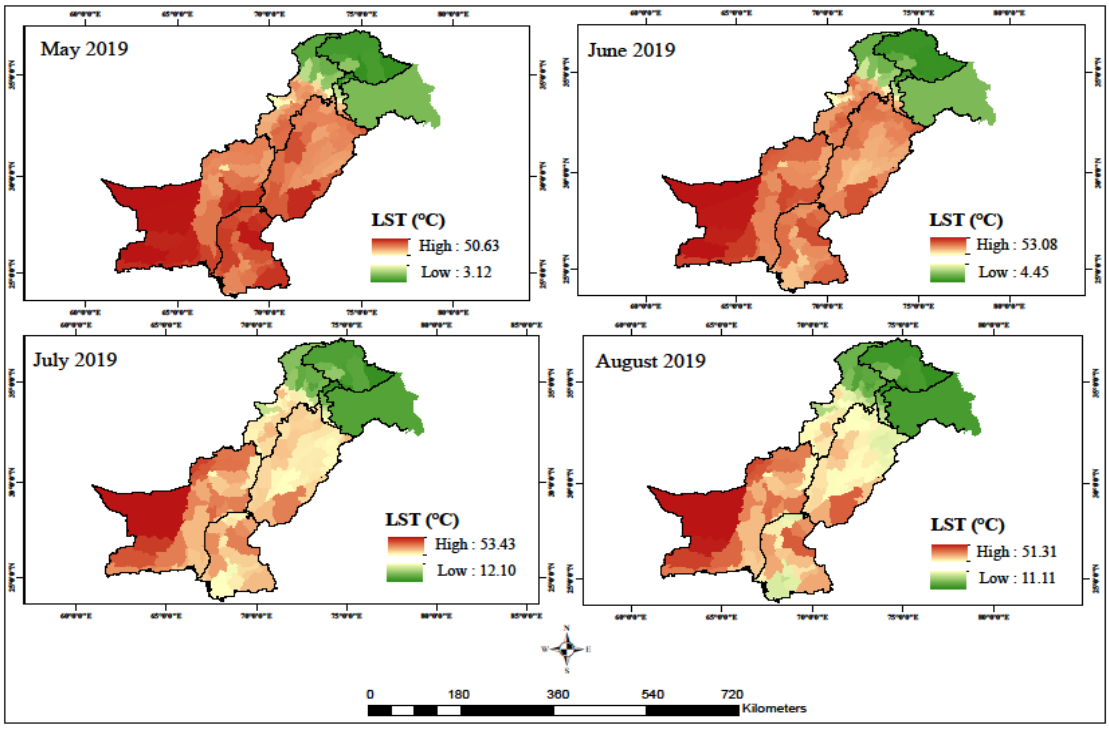

Figure 28: Spatial Distribution of LST Before Covid-19 Pandemic 2019

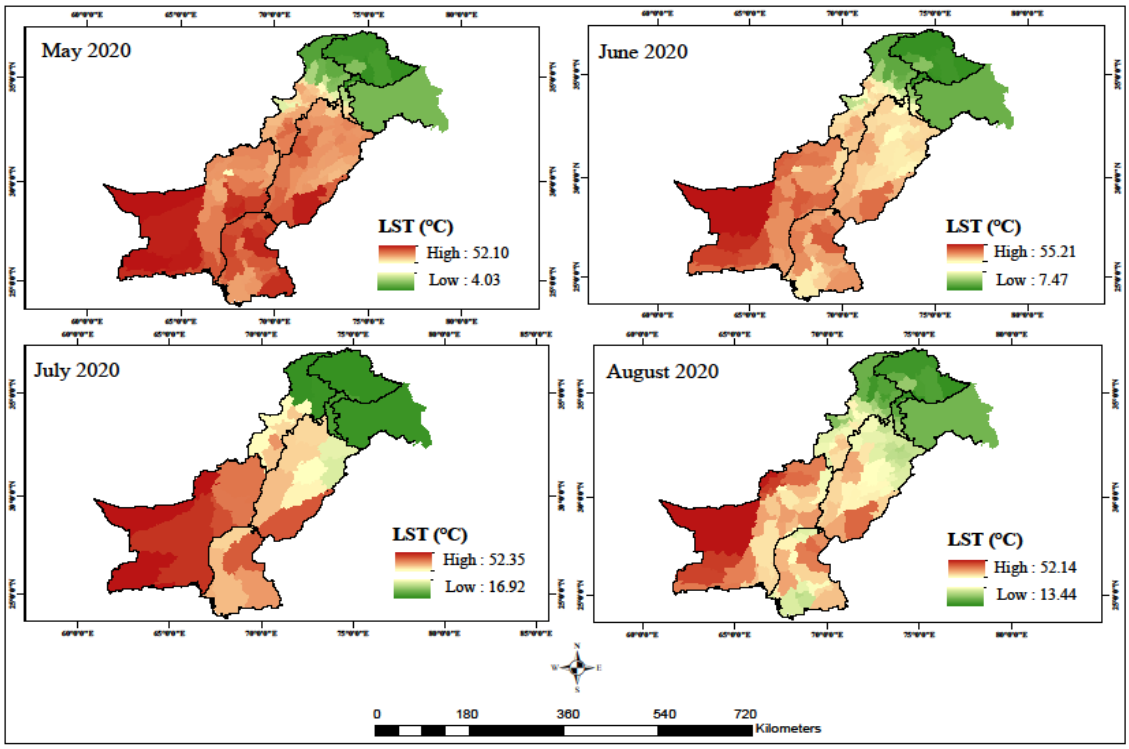

Figure 29: Spatial Distribution of LST During Covid-19 Pandemic 2020

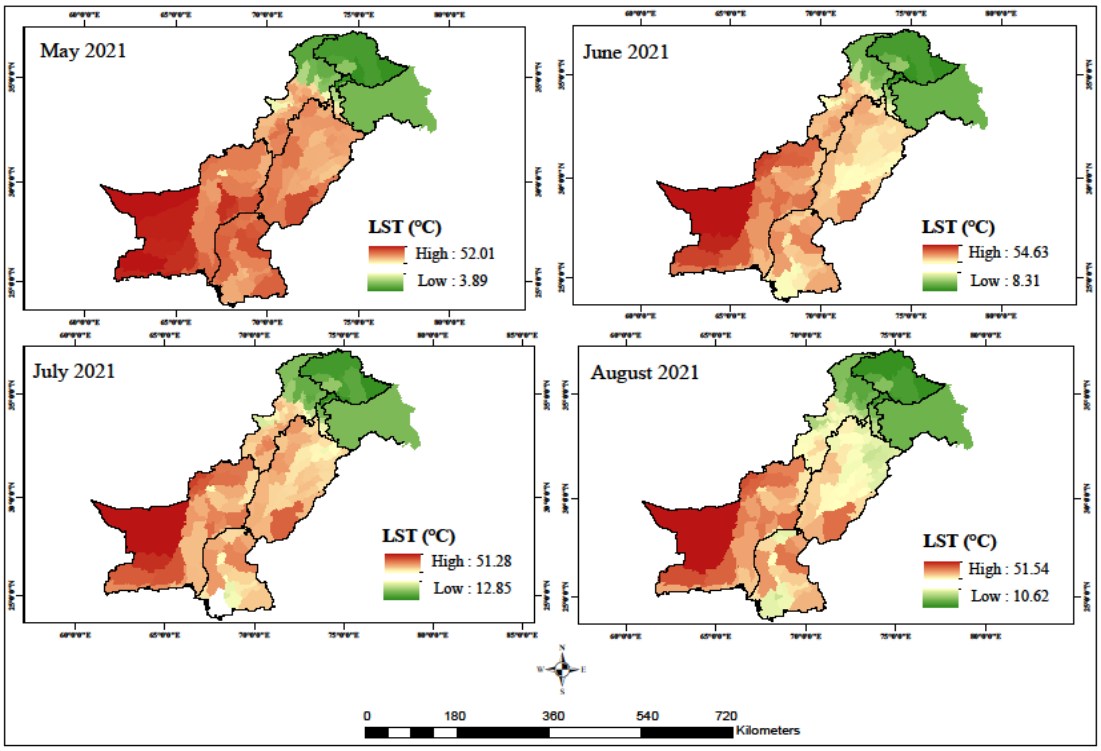

Figure 30: Spatial Distribution of LST During Covid-19 Pandemic 2021

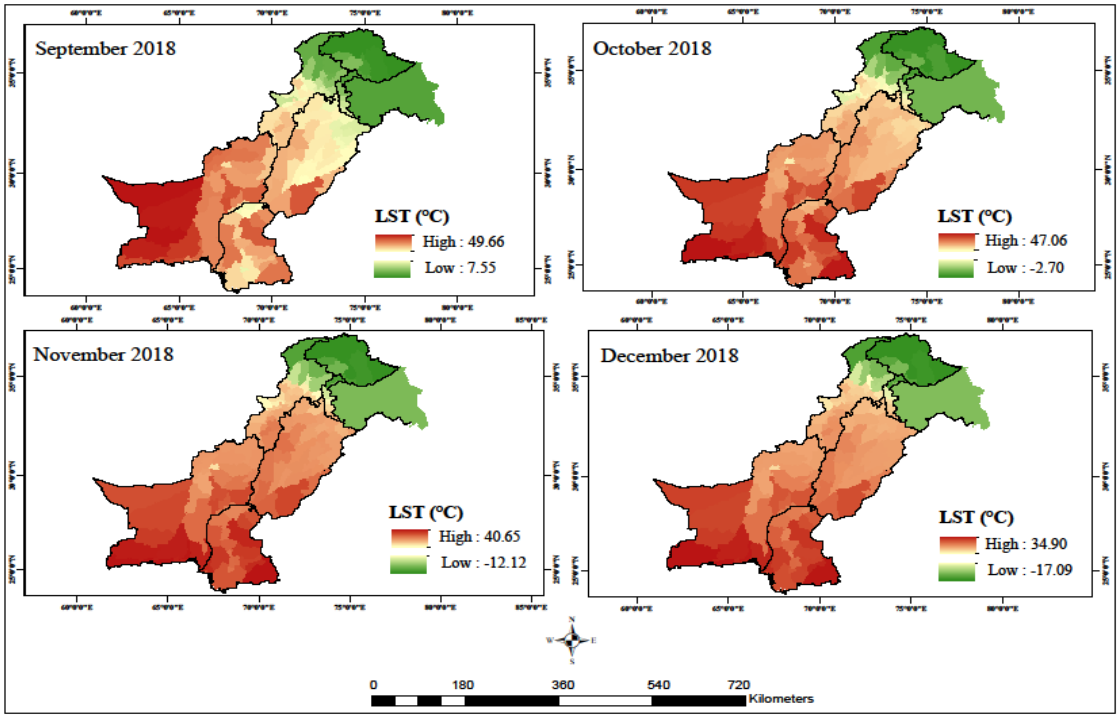

Figure 31 Spatial Distribution of LST Before Covid-19 Pandemic 2018

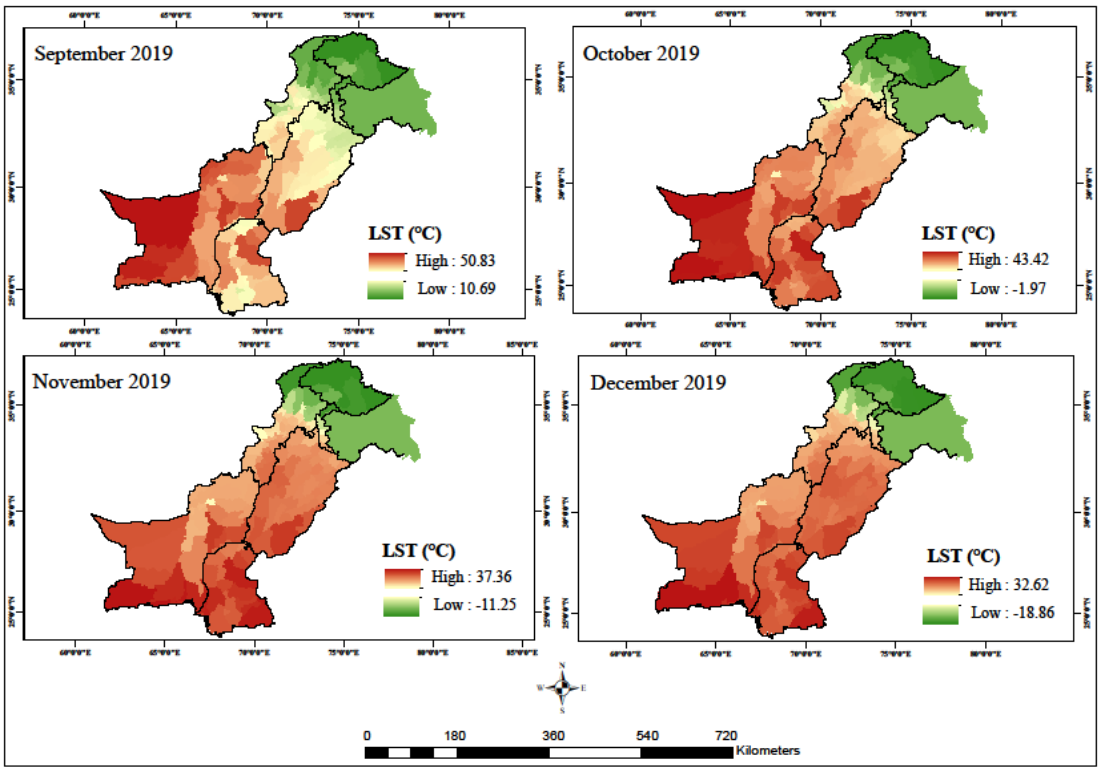

Figure 32: Spatial Distribution of LST During Covid-19 Pandemic 2019

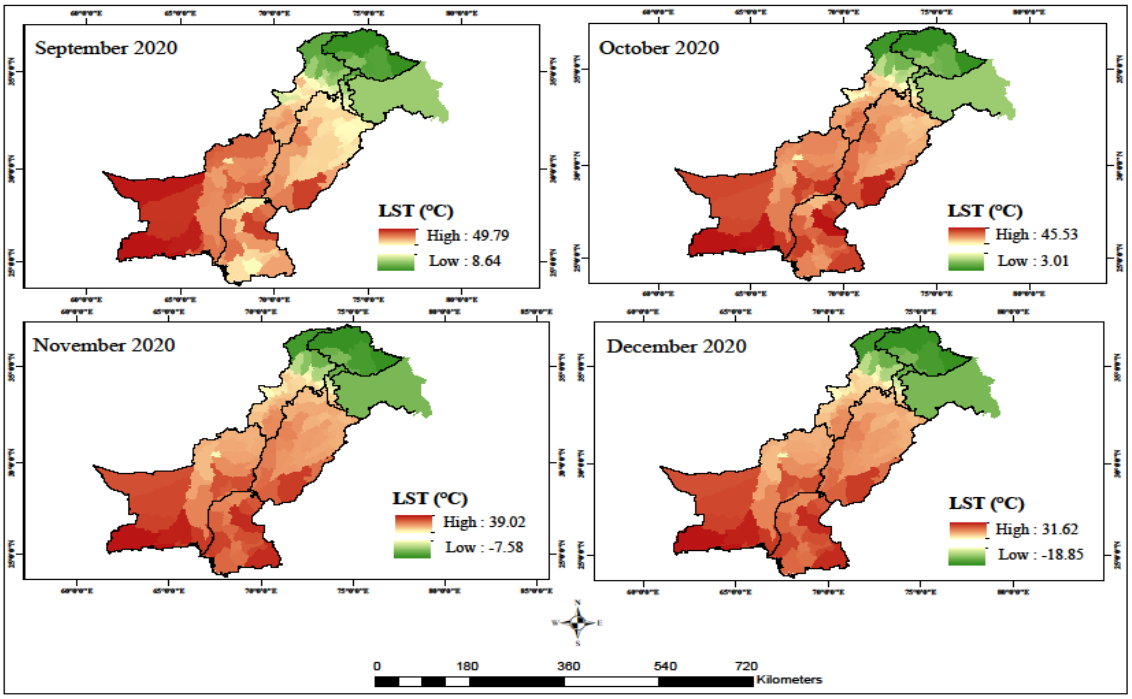

Figure 33: Spatial Distribution of LST During Covid-19 Pandemic 2020

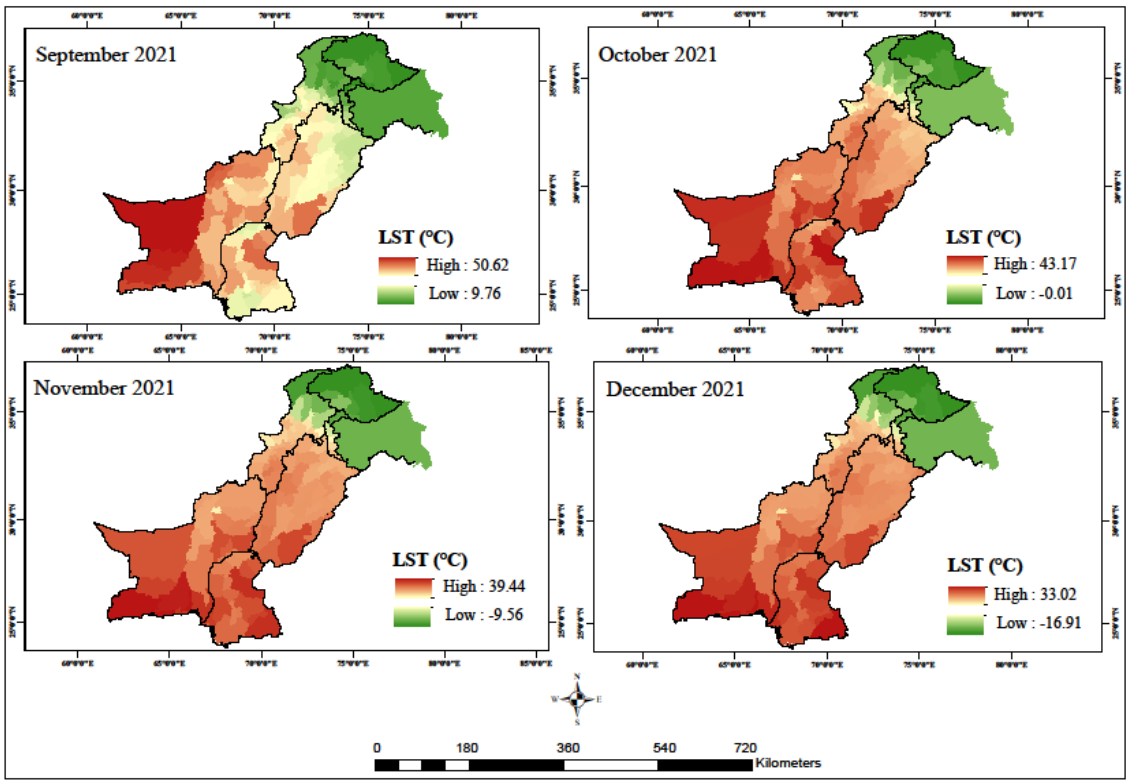

Figure 34: Spatial Distribution of LST During Covid-19 Pandemic 2021

Table 5: Statistics of LST during lockdown

LST(°C)	2018	2019	2020	2021
March	28	24	23	27
April	33	32	31	33
May	38	38	37	37
June	38	38	37	37

The main variations due to the lockdown period were observed during the 2020 pandemic year. Figure 24 and 29 and Figure 33 show the distribution of LST during the pandemic year 2020. The decrease in 2021 was basically due to a generally cooler weather pattern. Figure 25 and 30 and 34 portray spatial distribution during the COVID-19 pandemic of 2021. Figure 26 shows the distribution of LST during COVID-19 from January to March 2022. The variations in climatic conditions are very clear from the obtained results. A decreasing trend was observed during the lockdown period in wind speed and LST. Figure 35 shows the overall condition of selected environmental factors (wind speed and LST of prior years of the pandemic 2018 and 2019. Table 5 represents the district-wise average of LST during the lockdown period.

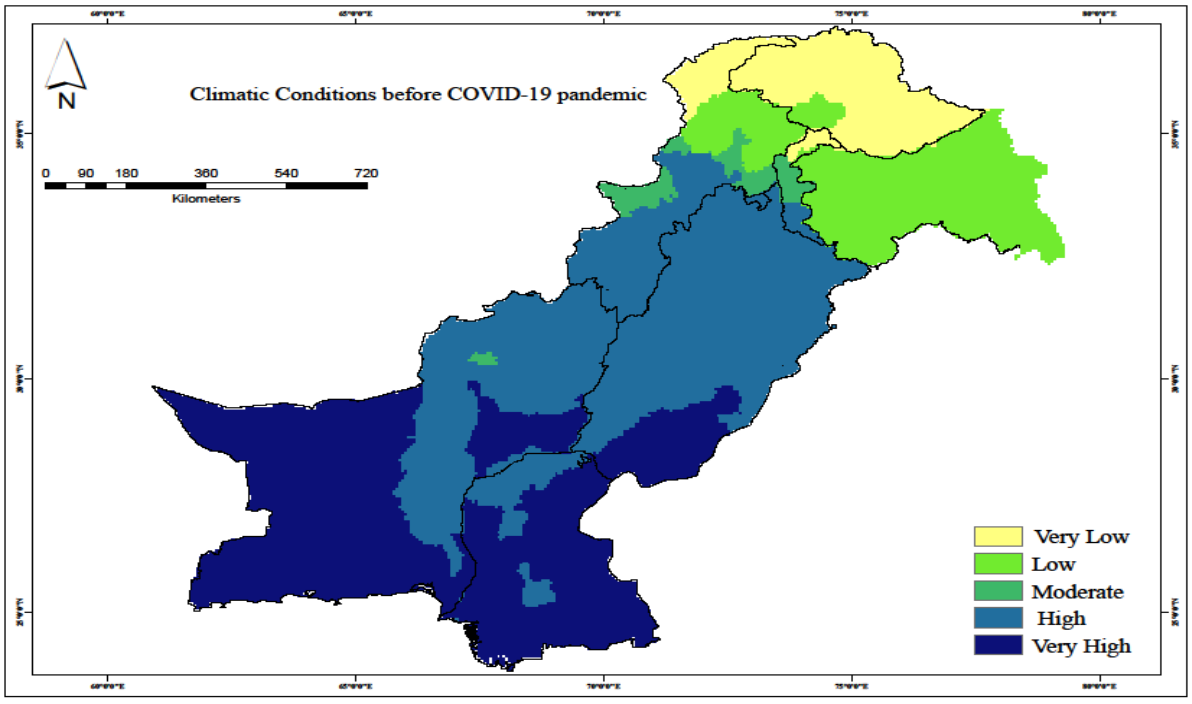

Figure 35: Spatial Distributions of Overall Environmental Conditions before Pandemic (LST, Wind Speed)

Figure 36 depicts how COVID-19 caused changes in climatic conditions during the COVID-19 pandemic in 2020, 2021 and 2022. The changes in climatic conditions were associated with lockdown period during the COVID-19 pandemic and also with a reduction in air pollutants resulting in changes in the trend of climatic conditions.

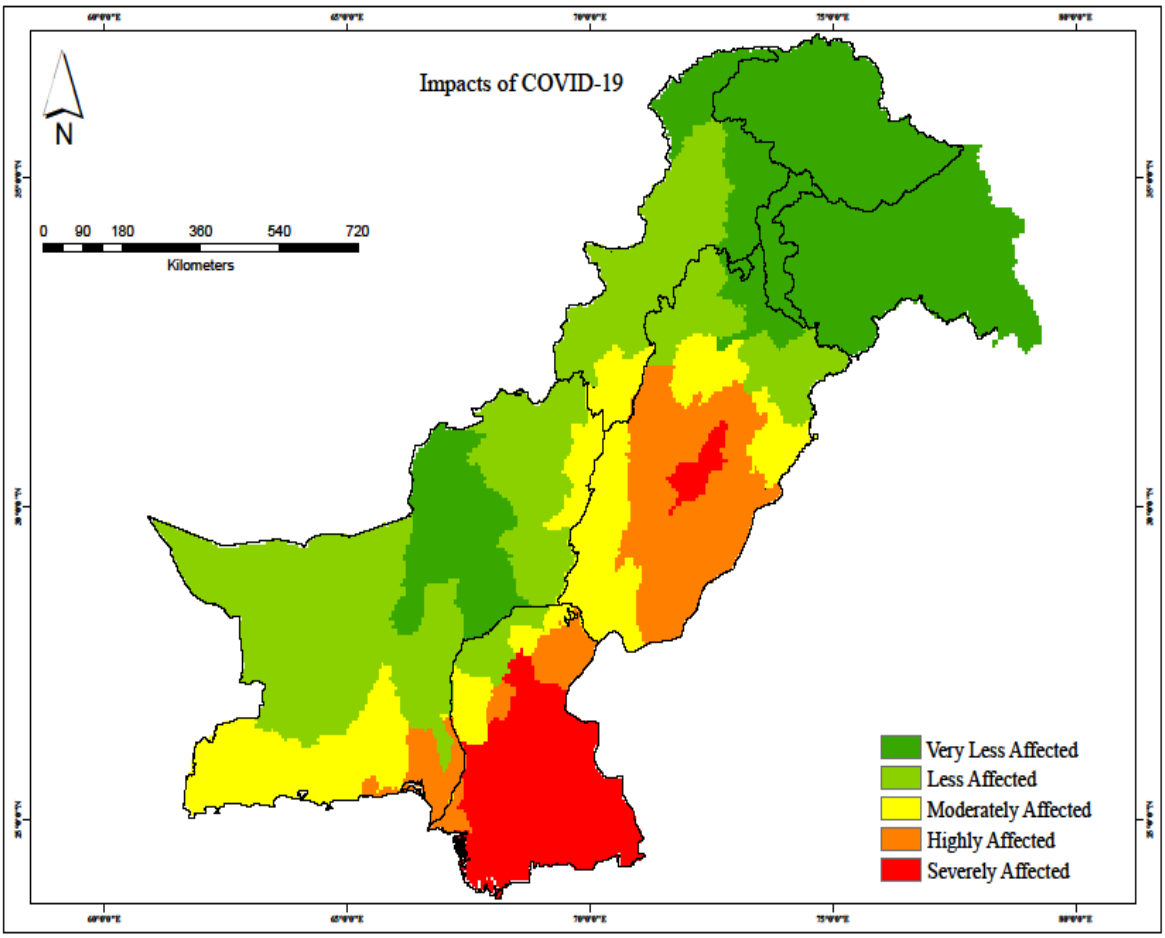

Figure 36: Impacts of Covid-19 on Climatic Conditions

Discussion

In this study the impacts of COVID-19 on environmental conditions and how preventive measures such as lockdown helped to control the spread of coronavirus and caused variations in climatic conditions were assessed over the country. From the obtained results of this research, it could be observed that the most affected province by COVID-19 was Sindh. To limit the spread of COVID-19 the government of Pakistan imposed the lockdown that not only controlled the spread of coronavirus cases but also caused variations in the climatic conditions over the country. The decreasing trend was observed in LST and wind speed in the study domain during

the strict lockdown period of 2020 and 2021. These variations in climatic conditions were mainly due to a decrease in anthropogenic activities, restricted transport and closure of industries during the lockdown period of the pandemic. A similar decreasing trend in LST was also observed over different parts of Europe during the lockdown period (Parida et al., 2021). The similar decreasing trend in wind speed was also observed over the different cities of India (Navinya et al., 2020). Lockdown policies during this pandemic around the world had led a way to explain human effects on the environment. This research is of great help to understanding the variation that occurred during the COVID-19 pandemic because this study is based on long-term data analysis and discussed all lockdown periods during the COVID-19 pandemic. And in this study, only secondary data is used and only statistical analysis is performed to understand the impacts of COVID-19 on environmental conditions at district level. In the future more, advanced satellite data can improve the results and ground-based data on metrological factors can be more useful to compare variations for this kind of research paper.

Conclusion

This study provides the impacts of COVID-19 on climatic conditions in Pakistan. The COVID-19 epidemic had improved temporarily climatic conditions around the world, owing to the large-scale reduction in human activities, transport, and industrial activities which caused positive changes in environmental conditions. The results of the present study showed a generally decreasing trend in LST and wind speed around the country during the lockdown period of the pandemic was observed. The variations were mainly due to lockdowns, limited transport and reduction in industrial production. These climatic factors and anthropogenic emissions returned to their standard levels as the government removed the preventive measure such as lockdown and restrictions on transport and also resumed industrial activities. However, this study provides improvements in climatic conditions can be achieved by adopting sustainable usage of transport and industrial production. Furthermore, only secondary data of climatic factors is used in this research to understand the impacts of COVID-19 on climatic conditions over the country. By using ground-based data for comparison the obtained results could be more accurate.

Recommendations

• The officials of government should make policies such as a brief lockdown and sustainable production of industries to control the concentration of atmospheric pollutants resulting in improvements in environmental conditions.

• The officials should take preventive measures to reduce fossils fuel usage resulting reduction in aerosol concentrations. This will cause positive changes in environmental conditions.

• The most significant outcome of this study is to suggest to policymakers and officials that such purposeful actions to reduce atmospheric pollution and even population density in cities can have serious consequences for human life.

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Authors' contributions

The authors declared that this research was done by the both authors named in this manuscript and all liabilities pertaining to claim relating to the content of this article will be borne by both of them. Hazeema Mumtaz conceived the research and drafted the manuscript. Kanwal Javid revised the manuscript. Both authors performed a review of the manuscript before approving its publication in this journal.

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Competing Interests

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