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Approximation of COVID-19 effect on land surface temperature using MODIS data over YSR district, India

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LST
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Abstract

This work involved using satellite-derived data to know the disparities in Land Surface Temperatures (LST) due to the COVID-19 pandemic. To know the effect of this pandemic on LST, MODIS data from three years before the pandemic (2017-2019) was procured and compared with post-pandemic data (2020-2022). It was observed that there is a decreasing trend in the LST, ranging from 17.13 to 15.76 in terms of average LST difference. The northern portion of the study area has pronounced LST variation than the southern portion. It was observed that post COVID LST has a strong positive correlation with pre COVID LST. The LST of 2022 has a positive correlation with the LST of 2017 and a slight correlation with the LST from 2018 to 2021. LST time series plots were presented in this study along with the GIS maps. This work supports the notion that COVID-19 has lowered LST relatively.

1. Introduction

Land surface temperature (LST) is an important parameter as it affects the population directly and needs to be checked regularly (Zhang, et al., 2019). The urban landscape change has changed the surface temperature patterns, especially in developed areas (Dutta, et al., 2019; Mukherjee & Singh, 2020). Land Use Land Cover changes have altered LST in many regions, and satellite-derived data was used to understand the LST dynamics (Guha & Govil, 2022; Ullah et al., 2019). Several studies have focused on investigating the effect of COVID-19 on LST using satellite products (Abir, et al., 2021; Bera, Chatterjee, et al., 2022; Ghosh, et al., 2022; Hidalgo García & Arco Díaz, 2022; Parida, et al., 2021; Teufel et al., 2021; Xiao, et al., 2021; Xin et. al., 2022). This work focuses on understanding the LST changes during preCOVID (2017-2019) and postCOVID (2020-2022) periods. YSR district of Andhra Pradesh state of India is chosen as a study area for this research.

2. Method

MODIS data was procured for the years starting from 2017 through 2022. The data was classified as preCOVID (2017-2019) and postCOVID (2020-2022). MOD11A2 products were used as they provide LST of 8 days average per pixel. They have a 1200 x 1200 km grid with a spatial resolution of one kilometer. LST images of daytime have a 0.02 scale factor with a 16-bit unsigned integer data type. The GIS maps were prepared using the composite images generated from all months for the years starting from 2017 to 2022. Time series plots of LST for these years are provided. The methodology used in this work is shown in Figure 1.

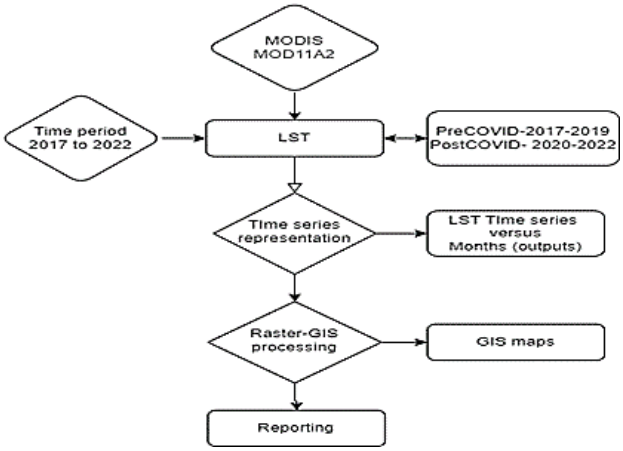

Figure 1. Methodology

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3. Results

The LST maps obtained in this study are given in figures 2 through 7. The LST map of 2017 showed that this region has a low temperature of 26.1°C and a high temperature of 43.5°C. The LST map of 2018 reflects that this region has a low temperature of 26.3°C and a high temperature of 43.8°C. The LST map of 2019 showed that this area experienced a low temperature of 27.2°C and a high temperature of 43.8°C. The LST map of 2020 explains that this area experienced a low temperature of 26.8°C and a high temperature of 43.2°C. The LST map of 2021 reflects that this area experienced a low temperature of 26.1°C and a high temperature of 41.7°C. The LST map of 2022 (without Dec) reflects that this area has a low temperature of 25.7°C and a high temperature of 41°C. The LST change is more evident in the north portion of the study area than south. This can be attributed to the natural geomorphological setup of the region. There are several high elevated areas in the south portion than the north.

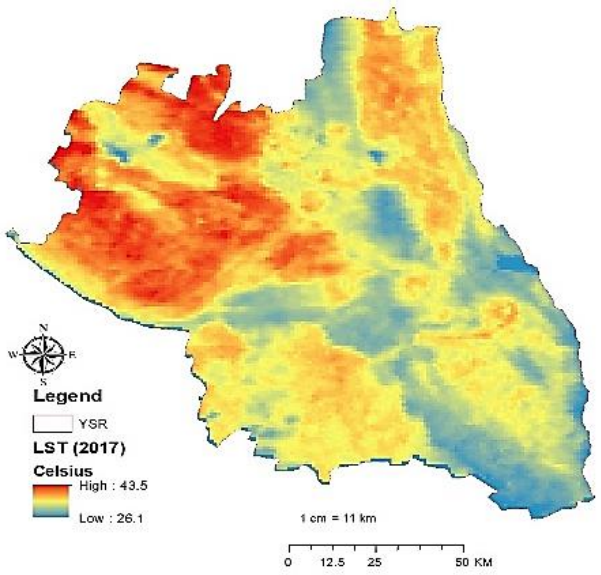

Figure 2. Land surface temperature (2017)

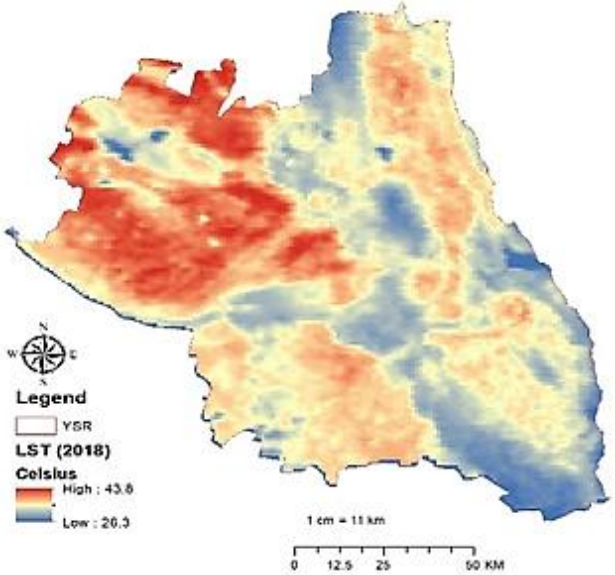

Figure 3. Land surface temperature (2018)

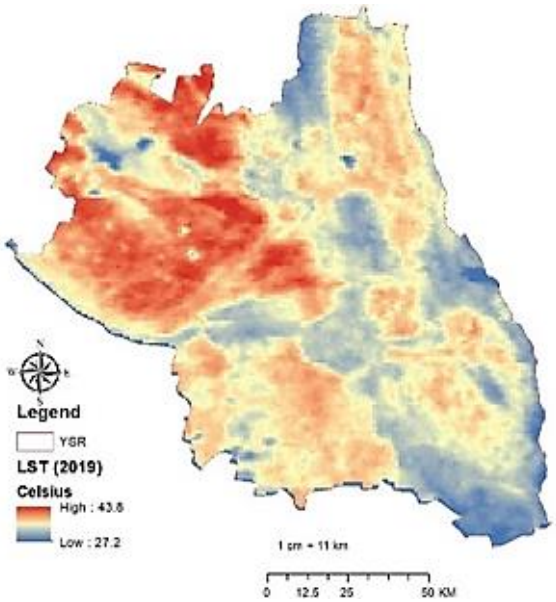

Figure 4. Land surface temperature (2019)

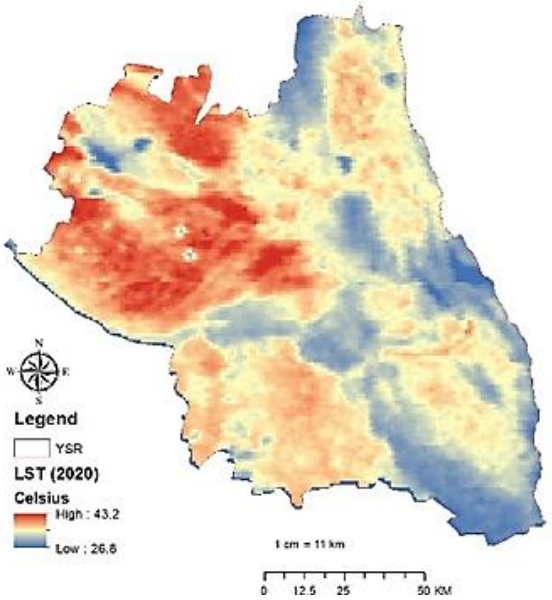

Figure 5. Land surface temperature (2020)

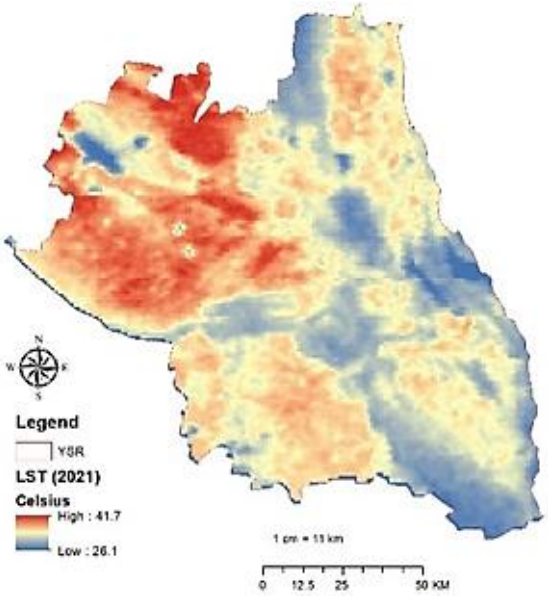

Figure 6. Land surface temperature (2021)

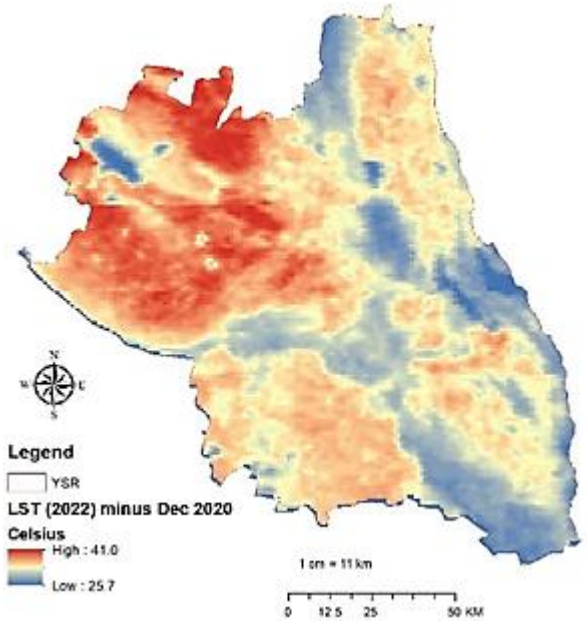

Figure 7. Land surface temperature (2022)

Figure 8. LST time series plot (2017)

Figure 9. LST time series plot (2018)

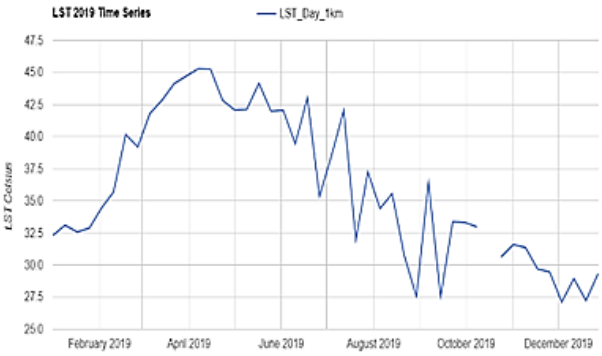

Figure 10. LST time series plot (2019)

Figure 11. LST time series plot (2020)

Figure 12. LST time series plot (2021)

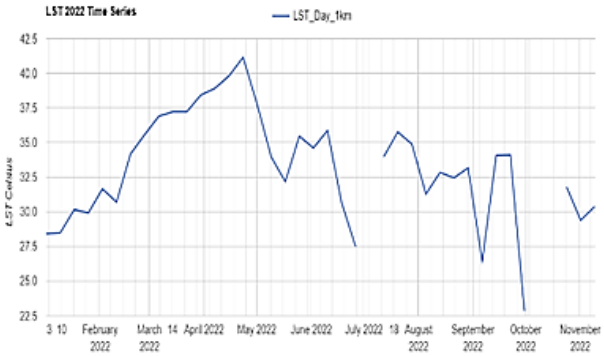

Figure 13. LST time series plot (2022)

	2017	2018	2019	2020	2021	2022
2017	1					
2018	0.748983	1				
2019	0.816605	0.694646	1			
2020	0.867334	0.811889	0.842392	1		
2021	0.823853	0.772584	0.78577	0.801296	1	
2022	0.745609	0.585115	0.656755	0.678405	0.597222	1

Figure 14. Correlation plot

The LST time series plots (LST-TS) obtained in this study are given in figures 8 through 13. The LST-TS of 2017 showed that there were high temperatures (>35°C) from February to August 2017 (slight dip in July) than the rest of the months. The LST-TS of 2018 reflects that there are high temperatures (>34°C) from February to October 2018 (slight dip in August) than the rest of the months. The LST-TS of 2019 showed that there were high temperatures (>35°C) from February to September 2019 (slight dip in August) than the rest of the months. The

LST-TS of 2020 showed that there are high temperatures (>35°C) from February to September 2020 (slight dip in August) than the rest of the months. The LST-TS of 2021 showed that there are high temperatures (>35°C) from February to July 2021 (slight dip in June) than the rest of the months. The LST-TS of 2022 showed that there are high temperatures (>35°C) from March to June 2022 (slight dip in may) than the rest of the months.

The post COVID (2020-2021(without 2022)) LST has a strong positive correlation with pre COVID (2017-2019) LST, and this is represented in figure 14 as a correlation plot. The LST of 2022 has a positive correlation with the LST of 2017 and a slight correlation with the LST from 2018 to 2021.

4. Discussion

This work was based on the hypothesis that there will be a hugely positive effect of the COVID-19 pandemic on LST. Through this work, it is evident that there is a slight decrease in the LST. This can be attributed to several factors, and lockdown is one of them. The decrease in air pollution has also contributed to a decrease in surface temperatures. The low and high temperatures recorded during pre-pandemic periods were 26.2/43.5°C, 26.3/43.8 °C, and 27.2/43.8°C respectively. The low and high temperatures recorded during post-pandemic periods were 26.8/43.2°C, 26.1/41.7°C, and 25.7/41°C, respectively. The temperature difference obtained was 17.3, 17.5, and 16.6 during the pre-pandemic period. The temperature difference obtained were 16.4, 15.6, and 15.3 during the post-pandemic period. There is a decreasing trend in the LST ranging from 17.13 (pre) (Averaged difference) to 15.76 (post) (Averaged difference).

5. Conclusion

This work supports the notion that the COVID-19 pandemic has a positive effect on LST owing to several other factors like lockdown, decreased pollution, etc. It is concluded that satellite-derived products (MODIS) with GIS processing can be used in understanding Land Surface Temperatures.

Acknowledgement

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