4th Intercontinental Geoinformation Days

igd.mersin.edu.tr

The effect of Covid-19 epidemic on the Land surface temperature of Asaluyeh Industrial City with an approach to image processing in Google Earth Engine Platform

Mostafa Mahdavifard [1], Shahin Jafari [*2], Khalil Valizadeh Kamran [1], Seyed Kazem Alavipanah [2]

[1] *University of Tabriz, Department of Remote Sensing and GIS, Tabriz, Iran*
[2] *University of Tehran, Department of Remote Sensing and GIS, Tehran, Iran*

Keywords
Land Surface Temperature
Covid-19
Google Earth Engine
Landsat Series
Remote Sensing

Abstract

At the end of 2019, the world became infected with the Covid-19 virus. In Iran, public places were declared quarantined and closed due to policy-making and social distancing. Land surface temperature is an important variable for the environment. The purpose of this study is to compare the LST extracted from Landsat 8 images in the new GEE for Asaluyeh Industrial City before, during and after the outbreak of Corona virus in April-May 2018, 2019, 2020 and 2021. The results of this study showed that the maximum temperatures in 2018, 2019, 2020 and 2021 for the city of Asaluyeh are 74.4, 61.2, 58.8 and 58.7 degrees Celsius, respectively. In fact, the city of Asaluyeh in the pre-Covid period experienced relatively high temperatures in residential areas and industrial towns, respectively, which were seen as hot spots in this period, but during the prevalence and epidemic of Corona due to closure and quarantine of cities, especially transportation, Factories and industries The LST has decreased significantly compared to the previous year, and after the normalization of epidemic conditions, ie in the post-corona period, due to the reduction of quarantine restrictions, we are witnessing an increase in temperature again in this city.

1. Introduction

Covid-19 virus was first reported in late December 2019 in the Huanan Seafood Market in Wuhan, China (Wuhan Municipal Health Commission, 2019). This nasty virus has spread rapidly worldwide and its epidemic has caused deaths worldwide (WHO, 2020). One effective way to reduce the effect of this virus is to apply quarantine. Quarantine conditions have led to the closure of academic institutions, public and private offices, restaurants, banks, public and private transport, factories, shops, etc. (Guha & Govil, 2021).

From the effects of urban blockage and environmental quarantine, decrease in air temperature and land surface temperature (LST) has been observed (Shi et al., 2020). Land surface temperature plays an important role in many studies such as climate change, agriculture, hydrology, land use and Land cover (LULC) (Avdan & Jovanovska, 2016). In general, heat in cities is caused by tire friction and smoke emissions from cars, as well as industrial sectors and areas such as power plants and petrochemicals, which affect air temperature and surface temperature (LST) in industrial cities (Phelan et al., 2015).

The city of Asaluyeh in Iran is known as an industrial city that was directly affected during the outbreak of Covid-19 virus, which resulted in the closure of factories, industries and petrochemicals and reduced human activities. These conditions cause the LST to change, so monitoring the LST is more important than before for environmental planners and managers. The quick development of remote sensing technology has made it possible to estimate the LST with satellite time series data, which has given rise to the online Google Earth engine (GEE) platform.

GEE is a computing platform for processing satellite imagery and spatial and geographic data in the cloud to integrate big data Petabyte-scale, including Landsat satellite data (Shelestov et al., 2017; Mahmoudzadeh et al., 2021).

* **Corresponding Author**

(mostafamahdavi842@gmail.com) ORCID ID 0000-0001-9811-5428
*(Shahin.jafari75@ut.ac.ir) ORCID ID 0000-0001-8593-7131
(valizadeh@tabrizu.ac.ir) ORCID ID 0000-0003-4648-842X
(salavipa@ut.ac.ir) ORCID ORCID 0000-0002-3554-111X

Cite this study

Mahdavifard, M., Jafari, S., Kamran, K. V., & Alavipanah, S. K. (2022). The effect of Covid-19 epidemic on the Land surface temperature of Asaluyeh Industrial City with an approach to image processing in Google Earth Engine Platform. 4th Intercontinental Geoinformation Days (IGD), 242-245, Tabriz, Iran

The aim of this study was to investigate the effect of Covid-19 virus on the surface temperature of Asaluyeh Industrial City. In line with the purpose of the study, surface temperature before, during and after Covid-19 were obtained from Landsat 8 images in the new GEE system.

2. Method

This section describes the steps of preprocessing and data processing in the GEE cloud space. Figure 1 shows the research processing flowchart.

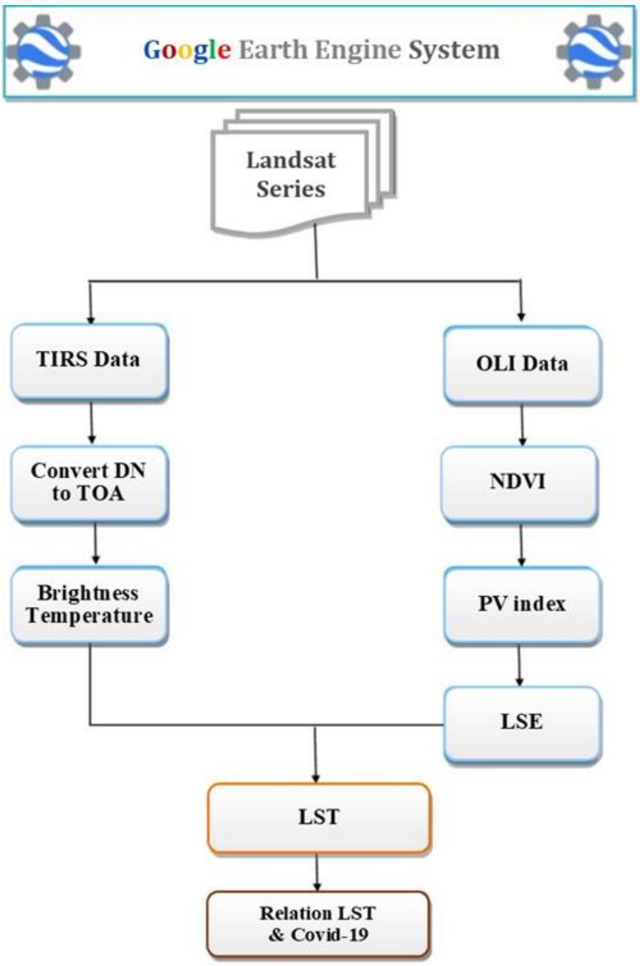

Figure 1. Flowchart of research process

2.1. Study area

Asaluyeh city is known as an industrial city in Iran. The geographical location of this city is located between north latitude 27° 29′ and 52° 37′ east longitude (Figure 2) and is located at an altitude of 5 meters above sea level. Content should be written in 2 columns with Cambria 10 font size.

The city has moderate and scattered vegetation with some dense palm lands and mangrove shrubs. The relative humidity of this region is between 59 to 88% and it receives 180 mm of rainfall annually. The population of this city is about 65 thousand people (Mokhtari Malek Abadi et al., 2016).

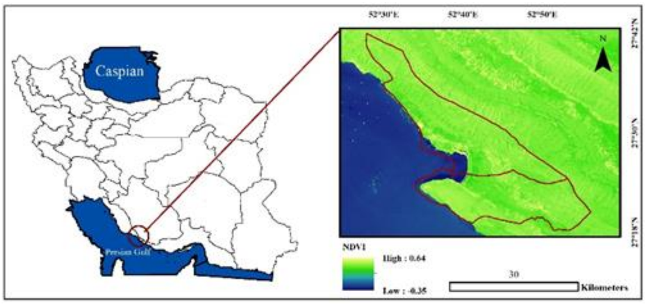

Figure 2. Geographical location of the study area

2.2. Datasets

To create a surface temperature map, satellite images of OLI and TIRS sensors in Landsat 8 related to 4 time periods were used on the Google Earth Engine platform. The criterion for selecting the date of satellite images in this study was the first quarantine apply In April and May 2020).

In order to validate the LST maps, the synoptic station data of 2018, 2019, 2020 and 2021 in the pre-, during and post-Covid-19 periods, respectively, were used. Table 1 shows the characteristics of the data used.

Table 1. Specifications of the data used

Image Satellite	Date of Acquisition	Climate Data	Temperature (°C)
Landsat-8	2018-5-13	Climate Station (CS)	36
	2019-5-15		35
	2020-5-16		33
	2021-5-19		34

2.3. Data Processing

In order to obtain the amount of spectral radiation above the atmosphere of band 10 of TIRS sensors, Equation 1 is used. Using this relation, the DN of the image can be converted to spectral radiation (USGS, 2020).

$$L\lambda = M_L \times Q_{cal} + A_L \quad (1)$$

Where Lλ high-spectral atmospheric radius, M_L specific band factor scaling factor, A_L specific band cumulative scaling factor, Q_{cal} specific band digital value (DN), M_L and A_L values are extracted from the MTL file (Ghorbannia et al., 2017).

Brightness temperature (BT) is the microwave radiation radiance traveling upward from the top of Earth's atmosphere. Equation 2 is used to convert spectral reflection to brightness temperature.

$$BT = \frac{K2}{In\ [(\frac{K1}{L\lambda}) + 1]} - 273.15 \quad (2)$$

Where BT is the brightness temperature of the satellite in Kelvin unit, K1 is the first thermal constant (specific band thermal conversion of the MTL file equivalent to 774.89), K2 is the second thermal constant (specific band thermal conversion of the MTL file is equal to 1321.08) and $L\lambda$ radiance Spectrum is the top of atmosphere (Xu & Chen, 2004).

The NDVI index is based on the relationship between energy absorption in the red range by chlorophyll and increased reflectance in the near infrared range for healthy vegetation. This index is calculated from Equation 3 (Rouse et al., 1974).

$$NDVI = \frac{Band5 - Band4}{Band5 + Band4} \quad (3)$$

NDVI is the normalized vegetation index, which is calculated using near-infrared (band 5) and red (band 4).

PV is a ratio of the vertical projection area of vegetation (leaves, stalks, and branches) on the ground to the total vegetation area (Neinavaz et al., 2020). The proportion of vegetation (Pv) calculated using the Equation 4 (Bendib et al., 2017):

$$NDVI = (\frac{NDVI - NDVI_{min}}{NDVI_{max} - NDVI_{min}})^2 \quad (4)$$

where Pv = Proportion of vegetation, $NDVImax$ = maximum value of NDVI = $NDVIv$ (NDVI Vegetation), and $NDVImin$ = minimum value of NDVI = $NDVIs$ (NDVI Soil).

To obtain the surface temperature, it is important to calculate the surface emission. The ratio between emissions from an object to its emission from a black body at a constant temperature is called emission. Surface emission is a comparative factor that expresses the brightness of black body (Planck's law) to predict emitted radiation and is calculated from Equation 5 (Ghorbannia et al., 2017).

$$\mathrm{LSE} = 0.004.\mathrm{Pv} + 0.986 \quad (5)$$

In this equation LSE is the land emission temperature and Pv is the Proportion of vegetation.

Land Surface temperature (LST) is a constant temperature that is calculated using the calculated parameters of thermal radiation, TOA radiation, and land surface emissivity from Equation 6 (Stathopoulou & Cartalis, 2007).

$$\mathrm{LST} = \frac{\mathrm{BT}}{\{1 + [(\lambda \mathrm{BT}/p)\ln\varepsilon\lambda]\}} \quad (6)$$

In this equation, BT is the brightness temperature, λ is the TOA radiation, $\varepsilon\lambda$ is the emission of phenomena, p is a constant coefficient equal to 1.4388.

3. Results and Discussion

The results of comparing synoptic station data with satellite LST map are given in Table 2.

The data recorded by the meteorological station in Table 2 have a difference of about 11 minutes with the satellite passing through the study area, which can be the reason for the difference of about 2 to 3 degrees Celsius. Because of the heterogeneity of the pixels and the changes of the surfaces in the urban area cause the value of the pixels to interfere and, consequently, there is a possibility of errors and differences in the estimation of the Land surface temperature. In general, both the meteorological station and the estimated temperature by satellite in the study city show the maximum temperature in 2019 (before Covid-19) and the minimum temperature in 2020 (during Covid-19).

Table 2. Comparison of estimated temperature from satellite and synoptic station

Date	LST Landsat (°C)	CS Temperature (°C)
2018-5-13	39	36
2019-5-15	37	35
2020-5-16	35	33
2021-5-19	36	34

The results (Figure 2) show that the surface temperature in the pre-Covid-19 period (2018 and 2019) has been increasing, while during Covid-19 (2020) the temperature of these areas has decreased significantly. On the other hand, during the normalization of coronavirus conditions (2021), the earth's surface temperature has increased relative to the period during Covid-19.

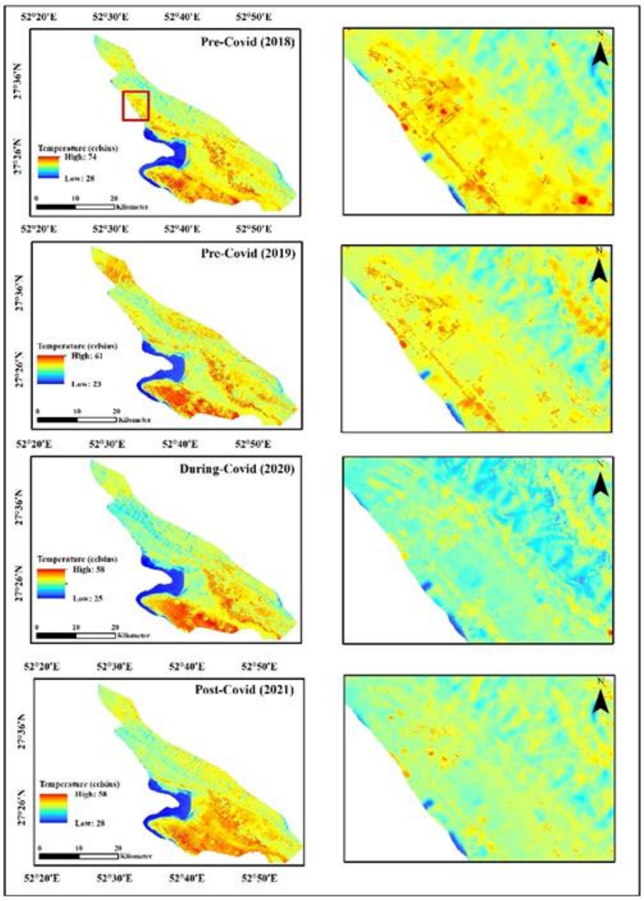

Figure 2. LST map before, during and after Covid-19

4. Conclusion

In this study, it was tried to investigate the changes in land surface temperature before, during and after Covid-19 in Assaluyeh industrial city. In order to conduct this research, Landsat-8 time series images were processed for extract LST in the Google Earth Engine platform (GEE). The results show that in the pre-covid-

19 period, the northern, western and eastern regions of Assaluyeh, where the factories, industries and residential areas of the city are located, respectively, had a temperature of more than 60 to 70 degrees Celsius, while the rate has decreased to about 58 ° C during and after the normalization of Covid-19 conditions in the country. In general, industrial activities, tourism, transportation have a direct impact on surface temperature and indirectly on the environment.

Nowadays, using remote sensing data can make the connection between Covid-19 and the LST easier, but processing this amount of satellite data into one piece of software is not easy, so in the end, researchers recommend using the new Google Earth Engine system. Because time series processing of LST changes on a monthly and annual basis provides easy.

References

Avdan, U., & Jovanovska, G. (2016). Algorithm for automated mapping of land surface temperature using LANDSAT 8 satellite data. Journal of sensors, 2016. https://doi.org/10.1155/2016/1480307

Bendib, A., Dridi, H., Kalla, M. I., (2017). Contribution of Landsat 8 data for the estimation of land surface temperature in Batna city, Eastern Algeria. Geocarto Int. 32, 503–513. https://doi.org/10.1080/10106049.2016.1156167

Ghorbannia, V., Mirsanjari, M., Liaghati, H. and Armin, M., (2017). Estimating land surface temperature of land use and land cover in Dena County using single window algorithm and landsat 8 satellite data. Environmental Sciences, 15(2), 55-74.

Guha, S., & Govil, H. (2021). COVID-19 lockdown effect on land surface temperature and normalized difference vegetation index. Geomatics, Natural Hazards and Risk, 12(1), 1082-1100.

Mahmoudzadeh, H., Mahdavifard, M., Azizmoradi, M., & Zanjani Sani, Z. (2021). Modeling physical development by combining the capabilities of Google Earth Engine (GEE) and Artificial Neural Network (MLP) the Case Study: Tabriz. Geography and Planning, 24(74), 215-232. https://doi.org/ 10.22034/gp.2021.10780

Mokhtry Malek Abadi, R., Marsosi, N., Hosaini, A. & Gholami, M., (2016). Assessing social â cultural sustainability in the extractive cities (Case: extractive city Asalooye). Spatial Planning, 5(4), 1-16.

Phelan, P. E., Kaloush, K., Miner, M., Golden, J., Phelan, B., Silva, H., & Taylor, R. A. (2015). Urban Heat Island: Mechanisms, Implications, and Possible Remedies. Annu. Rev. Environ. Resour. 40, 285–307. https://doi.org/10.1146/annurev-environ-102014-021155

Rouse, J. W., Haas, R. H., Schell, J. A., & Deering, D. W. (1974). Monitoring vegetation systems in the Great Plains with ERTS. NASA special publication, 351(1974), 309.

Shelestov, A., Lavreniuk, M., Kussul, N., Novikov, A., & Skakun, S. (2017). Exploring Google earth engine platform for big data processing: Classification of multi-temporal satellite imagery for crop mapping. Frontiers in Earth Science, 5, 17. doi.org/10.3389/feart.2017.00017.

Shi, P., Dong, Y., Yan, H., Zhao, C., Li, X., Liu, W., He, M., Tang, S., & Xi, S. (2020). Impact of temperature on the dynamics of the COVID-19 outbreak in China. Science of the total environment, 728, 138890. https://doi.org/10.1016/j.scitotenv.2020.138890Get rights and content.

Stathopoulou, M. & Cartalis, C. (2007). Daytime urban heat islands from Landsat ETM+ and Corine land cover data: An application to major cities in Greece. Solar Energy, 81(3), 358-368. https://doi.org/10.1016/j.solener.2006.06.014

World Health Organization, (2020). Considerations for quarantine of individuals in the context of containment for coronavirus disease (COVID-19): interim guidance, 19 March 2020 (No. WHO/2019-nCoV/IHR Quarantine/2020.2). World Health Organization.

Wuhan Municipal Health Commission: Report on current pneumonia epidemic situation in the city. 2019. http://wjw.wuhan.gov.cn/front/web/showDetail/2019123108989

Xu, H. Q., & Chen, B. Q. (2004). Remote sensing of the urban heat island and its changes in Xiamen City of SE China. Journal of Environmental Sciences, 16(2), 276-281. https://doi.org/1001-0742(2004)02-0276-06.