7th Intercontinental Geoinformation Days

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Monitoring changes in air pollution using Sentinel-5 data

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Keywords
Remote sensing,
Sentinel images-5
Air pollution,
Aerosol

Abstract

Today, air pollution is one of the most important issues in the field of environment and human health. In the last few years, remote sensing has helped a lot in the field of monitoring, measuring the concentration of pollutants. In this article, the monitoring of air pollution changes with Sentinel 5 satellite images in the southwest of Iran was discussed. Sentinel 5 images were received using the Google Earth Engine system in January 2022 to January 2023. After the detection of NO2, CO, UV-Aerosol and SO2, a map of atmospheric pollutants with color layers was obtained and then the one-year time changes of No2, Co, UV-Aerosol and SO2 were determined with a graph. The results of the graph of monthly changes showed that the concentration of NO2 and CO in spring and summer have the highest concentration, UV-Aerosol has the highest concentration in spring, and September and October have the highest concentration for SO2 in the center and southwest of Khuzestan province.

1. Introduction

Various factors are effective in producing air pollution that have adverse effects on the health of living organisms (Safarianzengir et al., 2020). Pollutants are classified in terms of physical state (solid, liquid and gas), emission source (mobile, fixed, natural, man-made) (Tiwary and Colls, 2009) and are one of the most important environmental issues, especially in advanced industrial countries and is developing (Meetham, 2016).

The most important air pollutants are carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and aerosol (AI) (WHO, 2010).

The World Health Organization (WHO-2020) reported that about 91% of the earth's population is exposed to air pollution with high levels of pollutants, which leads to the death of 7 million people annually.

In addition, air pollution threatens the health of all age groups, especially children (Vidotto et al., 2012), leads to cardiovascular diseases (Cesaroni, 2014), impaired fertility (Slama, 2013) and is a serious threat to It is the health of society.

Using remote sensing techniques is one of the most efficient methods to study pollution in the atmosphere (Duncan et al., 2014; Li, 2020).

In the past years, the western regions of Iran have been heavily affected by various air polluting phenomena, such as fine dust, due to their neighborhood with desert areas. One of the most damaged areas is Khuzestan province, which is in the danger zone for many days of the year. Therefore, in this study, air pollution in this area has been monitored using remote sensing (Ghaderi and Azizi, 2019).

2. Materials and methods

2.1. Study Area

The latitude and longitude of the study area is, 47°, 50° E and 30° 33° N respectively. It is the fifth most populous province of Iran with an area of 640057 square kilometers, it is located in the southwest of Iran on the shores of the Persian Gulf and the Arvand River. Due to the proximity to the Persian Gulf and the dry and burning winds of the Arabian Peninsula, it is a dry region and has a desert climate (Ghaderi and Azizi, 2021).

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Cite this study

Ghaderi, B., Safaval, A., P., & Azizi, Z. (2023). Monitoring changes in air pollution using Sentinel-5 data, Intercontinental Geoinformation Days (IGD), 7, 71-74, Peshawar, Pakistan

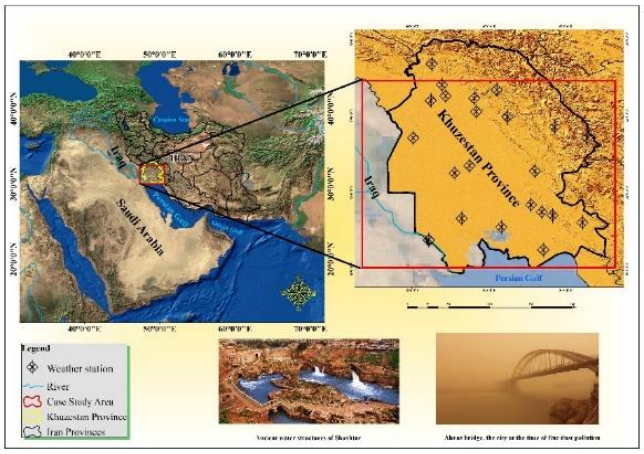

Figure 1. Study area

2.2 Method

This study is non-interventional and descriptive-analytical. Using the JavaScript programming language in the GEE environment, the products related to CO, SO2, NO2 and AI pollutants were called with Sentinel-5 images and the time period of 2022 to 2023 for monitoring atmospheric pollutants and determining polluted centers in the area of Khuzestan province of Iran was selected.

The required ground data was obtained from 22 meteorological stations (Figure 1). In the following, it was used to measure the changes in the concentration of different polluting gases. Then, the amount of air gases, carbon monoxide, nitrogen dioxide and sulfur dioxide in the atmosphere was checked and monitored. The required ground data was obtained from 22 meteorological stations.

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Using the Google Earth Engine Polygon system, the studied area was called, then the products related to the atmospheric pollutants UV-Aerosol, CO, NO2, and SO2 were received and analyzed during a ten-day time period, i.e. from November 1, 2022 to November 10, 2022.

Finally, the spatial map of air pollutants was obtained separately according to the average concentration of ten days and by the color combination method. and its concentration was displayed by Dataset Visualization parameters with color,

In order to monitor the temporal and spatial changes of pollutants, the monthly graph of changes during a one-year period was obtained from January 2022 to January 2023, and the average concentration of pollutant centers and aerosols was obtained.

The results obtained from the generated maps indicate the distribution of pollutant concentrations. (**Figure 2**).

3. Results

3.1. Slope of changes in air pollution

The average monthly changes of the amount of CO pollutant in 2022 to 2023 in different months are between 0.40-0.80 mol/m^2. The highest amount of CO gas started from May 2022 as an upward slope and continued until September, after which it had a downward slope.

According to the results, the decreasing trend of CO is in March and April and its lowest concentration is in November, so according to the graph, there is the highest concentration of carbon monoxide in spring and summer.

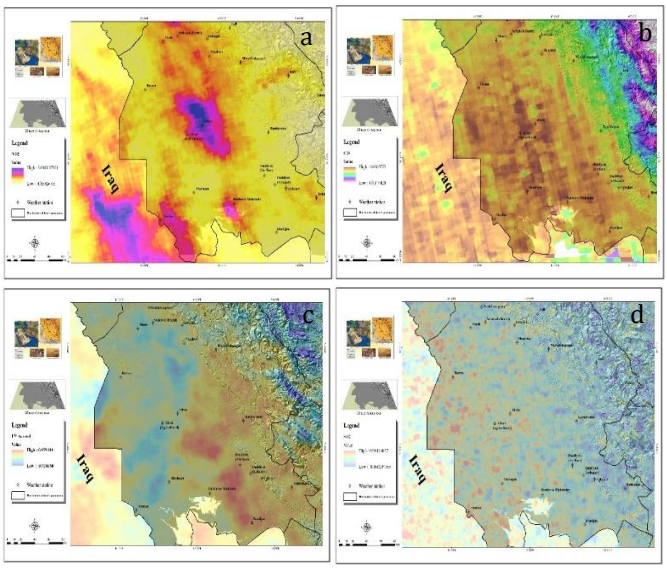

Figure 2. a) NO_2 pollutant distribution b) CO pollutant distribution c) UV-Aerosol pollutant distribution d) SO_2 pollutant distribution.

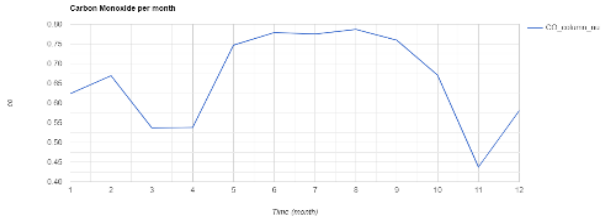

Figure 3. Chart of monthly CO changes from January 2022 to January 2023.

The graph of monthly changes of NO_2 pollutant shows that the trend of changes in February and March was at the lowest and constant .In spring and summer, NO_2 concentration has increased. With the change of season from summer to autumn, there has been a decreasing trend.

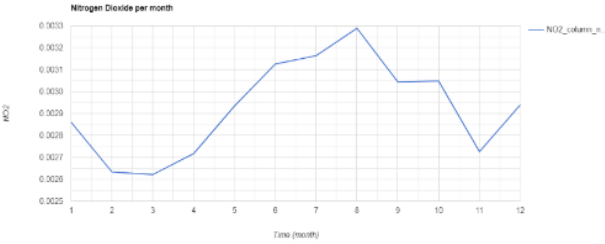

Figure 4. Chart of monthly NO2 changes from January 2022 to January 2023.

The graph of concentration changes for SO2 pollutant shows a lot of fluctuation. In the first month to the third month of the year, it had a downward slope and in the month of March, it had the minimum concentration. From

the beginning of May, which means spring and summer, the amount of SO_2 is on the rise and shows a high concentration.

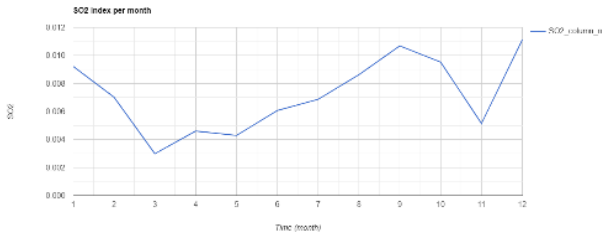

Figure 5. Chart of monthly SO2 changes from January 2022 to January 2023.

According to the chart of changes in the amount of aerosols in the atmosphere, it shows that the spring season had the maximum concentration of aerosols, and the highest concentration was in the month of May, which reduced the horizontal visibility to at least 100 meters (Figure 3).

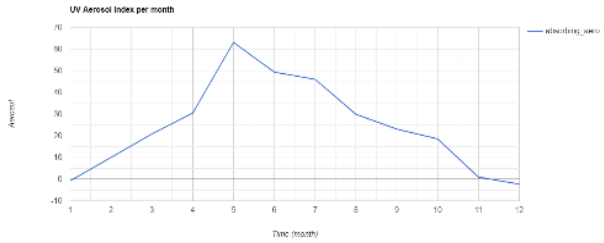

Figure 6. Chart of monthly SO_2 changes from January 2022 to January 2023.

The data of meteorological stations of Khuzestan province were used for validation in this research and the dust event was recorded in 5 stations of Ahvaz, Shadgan, Handijan, Abadan and Omidiyeh on October 1, 2022 to October 3, 2022 at 6, 9 and 12 hours with horizontal visibility of less than 100 meters.

In the Google Earth Engine environment, a three-day graph and a spatial map of aerosols were obtained and compared with the results at the stations. Finally, the results were correct (Figure 7).

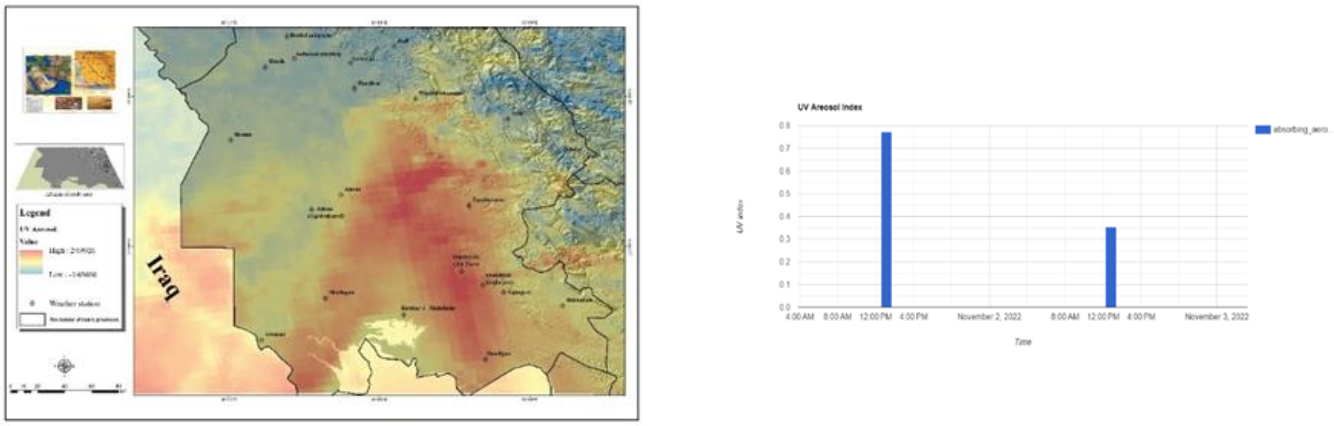

Figure 7. Validation results according to meteorological data

4. Discussion

When the concentration of gases exceeds a limit and is dangerous for human health, it is considered air pollution, so it causes environmental problems. Many studies have been done with different methods for monitoring, preventing and predicting air pollution, and remote sensing and GIS have greatly helped in pollutant monitoring.

Many studies have been done regarding the estimation of pollutant concentration with satellite images.

5. Conclusion

Iran is facing a decrease in the middle and upper levels of the troposphere during the hot seasons due to its location in the subtropical high-pressure dynamic currents.

With the continuation and vertical expansion of the high-pressure subtropical current, a hot and dry air mass is formed on the plateau of Iran. which, by affecting other atmospheric variables, leads to the dryness of large areas of Iran.

The main sources of dust for dust storms in southwestern Iran are a range between northern and central Iraq, northern Saudi Arabia and eastern Syria (Rivandi et al., 2013).

The phenomenon of dust in Khuzestan province has human and natural factors, among which the droughts of recent years can be mentioned as the most important. Also, dam construction, water transfer to dry areas, agriculture, Iraq and Iran war are human factors involved in increasing the severity of the crisis (Rshnv, 2009).

In the meantime, the storms that enter Khuzestan by the air currents of Saudi Arabia and Iraq have destructive effects on the air quality and environment of this region (Ghaderi, 2020).

The results of the present study showed that the distribution of atmospheric pollutants in the south and southwest of Khuzestan province, that is, in the weather stations of Ahvaz, Abadan, Shadgan, Omidiyeh, Handijan, had the highest concentration, it is abundantly clear on the map of the southwestern border of the country.

Therefore, according to the validation map of aerosol centers in the southwest of Iran, the eastern regions of Iraq were more.

The results of the graph of changes in the average concentration of atmospheric pollutants in 2022 to 2023

showed that the concentration of NO2 and CO in the months of May to October has the highest level and UV-Aerosol has the highest concentration in the months of May, June and July. Also, September and October show the highest concentration of SO_2 in the center of Khuzestan province and Ahvaz city.

References

Cesaroni, G., Forastiere, F., Stafoggia, M., et al. (2014). Long term exposure to ambient air pollution and incidence of acute coronary events: prospective cohort study and meta-analysis in 11 European cohorts from the ESCAPE Project." Bmj 348.

Duncan, B. N., Prados, I., Lamsal, N. L., Liu, Y., Streets, D. J., Gupta, P. (2014). Ernest Hilsenrath et al. "Satellite data of atmospheric pollution for US air quality applications: Examples of applications, summary of data end-user resources, answers to FAQs, and common mistakes to avoid." Atmospheric environment ,94, 647-662.

Ghaderi B., Azizi Z (2021). HYSPLIT algorithm in dust source Identifying and modeling. Intercontinental Geoinformation Days (IGD), Vol. 4: 239-241.

Ghaderi, B., Azizi, Z. (2019). Detecting and monitoring dust storm and studying the effect of temperature and relative humidity parameters using remote sensing. 2ND Conference of the Arabian journal of geosciences (CAJG) 25-28 November, Sousse, Tunisia.

Ghaderi, B., Azizi, Z. (2020). Monitoring of dust phenomenon and Investigate its correlation with temperature and humidity parameters (Case study: Khuzestan Province). Journal of Geomatics Science and Technology, 9(4), 51-60.

Li, J. (2020). Pollution trends in China from 2000 to 2017: A multi-sensor view from space, Remote Sensing, 12(2), 208.

Meetham, A. R., Bottom, D. W., Cayton, S., (2016). Atmospheric pollution: its history, origins and prevention. Elsevier Books.

Rivandi, A., Mirrokni, M., Mohammadiha, A. (2013). Investigation of Formation and Propagation of Dust Storms Entering to the West and Southwest of Iran Using Lagrangian Particle Diffusion Model, HYSPLIT, Journal of Climate Research, 1392(13), 1-16.

Rshnv, A. S. (2009). Dust phenomenon Ghbardr Khuzestan province, quarterly rainfall, Ahvaz, Khuzestan province meteorological Station.

Safarianzengir, V., Sobhani, B., Yazdani, M. H., Kianian, M., (2020). Monitoring, analysis and spatial and temporal zoning of air pollution (carbon monoxide) using Sentinel-5 satellite data for health management in Iran, located in the Middle East, Air Quality Atmosphere & Health, 13: https://doi.org/10.1007/s11869-020-00827-5.

Slama, R., Bottagisi, S., Solansky, I., Lepeule, J., Giorgis-Allemand, L., Sram, R., (2013). Short-term impact of atmospheric pollution on fecundability. Epidemiology, 871-879.

Vidotto, J. P., Pereira, L. A. A., Braga, A. L. F., Silva, C. A., Sallum, A. M., Campos, L. M., Martins, L.C., Farhat, S. C. L., (2012). Atmospheric pollution: influence on hospital admissions in paediatric rheumatic diseases, Lupus, 21(5), 526-533.