

Trend of Three Main Air Pollutants of Tehran City by Sentinel-5 †

Fatemeh Pazoki *, M. Ángeles García, Isidro A. Pérez, Saeed Rasekhi

Department of Applied Physics, Faculty of Sciences, University of Valladolid, Paseo de Belén, 7, 47011 Valladolid, Spain. magperez@uva.es (M.A.G.); isidro.perez@uva.es (I.A.P.); saeed.rasekhi22@estudiantes.uva.es (S.R.)

*Correspondence: fatemeh.pazoki22@estudiantes.uva.es (F.P.)

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Abstract: During recent years, by expanding cities, air pollution is one of the most important problems made by humans. Tehran, as the capital of Iran, is expanding gradually and its population is rising day by day. Therefore, the increase of human activities causes many problems, such as air pollution in this area. In this study, data of Sentinel-5 for Tehran city are used from last month of 2018 to present, and collected by Google Earth Engine. Three main parameters of air pollution have been studied, such as aerosol, ozone and CO. Different statistics of each parameter are calculated. Then, temporal evolutions are analyzed using Statgraphics. The analysis is calculated for aerosol median is $-0.555 \text{ mol m}^{-2}$ and interquartile range is 1.248 mol m^{-2} . For ozone parameter median is calculated as 0.131 mol m^{-2} and interquartile range as 0.015 mol m^{-2} . Also, for CO parameter, median is 0.037 mol m^{-2} and interquartile range is 0.011 mol m^{-2} . Total trend of aerosol is increasing, in additional during the summer months, aerosol amounts are higher than in winter months. Statistics have shown a decreasing trend for ozone parameter, but in winter months ozone are higher than in summer months. The trend for aerosol and ozone are statistically significant at 95% confidence level. Trend of CO is totally stable but a little higher at the end of fall and first days of winter.

Keywords: air pollution, Sentinel-5, Tehran, ozone, co, aerosol

1. Introduction

Among developing countries, changing in climate and weather situation and growing rate of polluted parameters in air turn into two core apprehension in universe. Climate change has a substantial exert influence air pollution by affecting meteorological essentials. And air pollutants can influence variations in the climate structure by affecting atmospheric radiation and cloud formation [1]. Population of Tehran has amplified about 2.5 times and urban areas has enlarged 8.5 times during last years [2]. Rapid urbanization has been associated with the emergence of industrial units, electricity production and refineries in Tehran during this era. These influences, accompanied by topographical state of affairs that affect air pressure, temperature and inversion phenomenon, have led to an increase in the concentration of air pollutants in Tehran and cardiovascular and respiratory deaths [3,4].

Opposing healthiness effects linked with various air pollutants accentuate the inevitability of leading trend revisions. For example, CO can enter the body through the lungs, and has the potential to reduce the oxygen-carrying capacity of the blood, thereby affecting the circulatory system and the delivery of oxygen to organs and tissues [5].

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As an illustration, distressing the cardiovascular organization and the distribution of oxygen to organs and matters because of entering CO in body by breathing then latently decrease the oxygen-carrying capacity of the blood [5].

Aerosols play an essential protagonist in atmospheric progressions because they are colloids of liquid or solid particles postponed in the air [6,7]. Aerosols are various negotiators that affect air superiority, climate, human health, and the hydrological cycle through various mechanisms [7,8]. The incoming and outgoing solar radiation and interrupt the radiative heating and cooling of the Earth's surface have efficacy by aerosols, by this means changing the energy balance [9].

Ozone is one of the most important photochemical oxidant that applies contrary effects on human health, in conjunction with ecological compensations agronomic crops and supplies at confident attentiveness stages [10,11]. Though numerous ozone switch plans that have been developed, investigation on its properties is thus far ongoing by cause of the attendance of various causes of forerunner releases, nonlinear associations between ozone and its forerunners, and the effect of meteorological and climatological features on ozone buildup and conveyance [12].

2. Methods

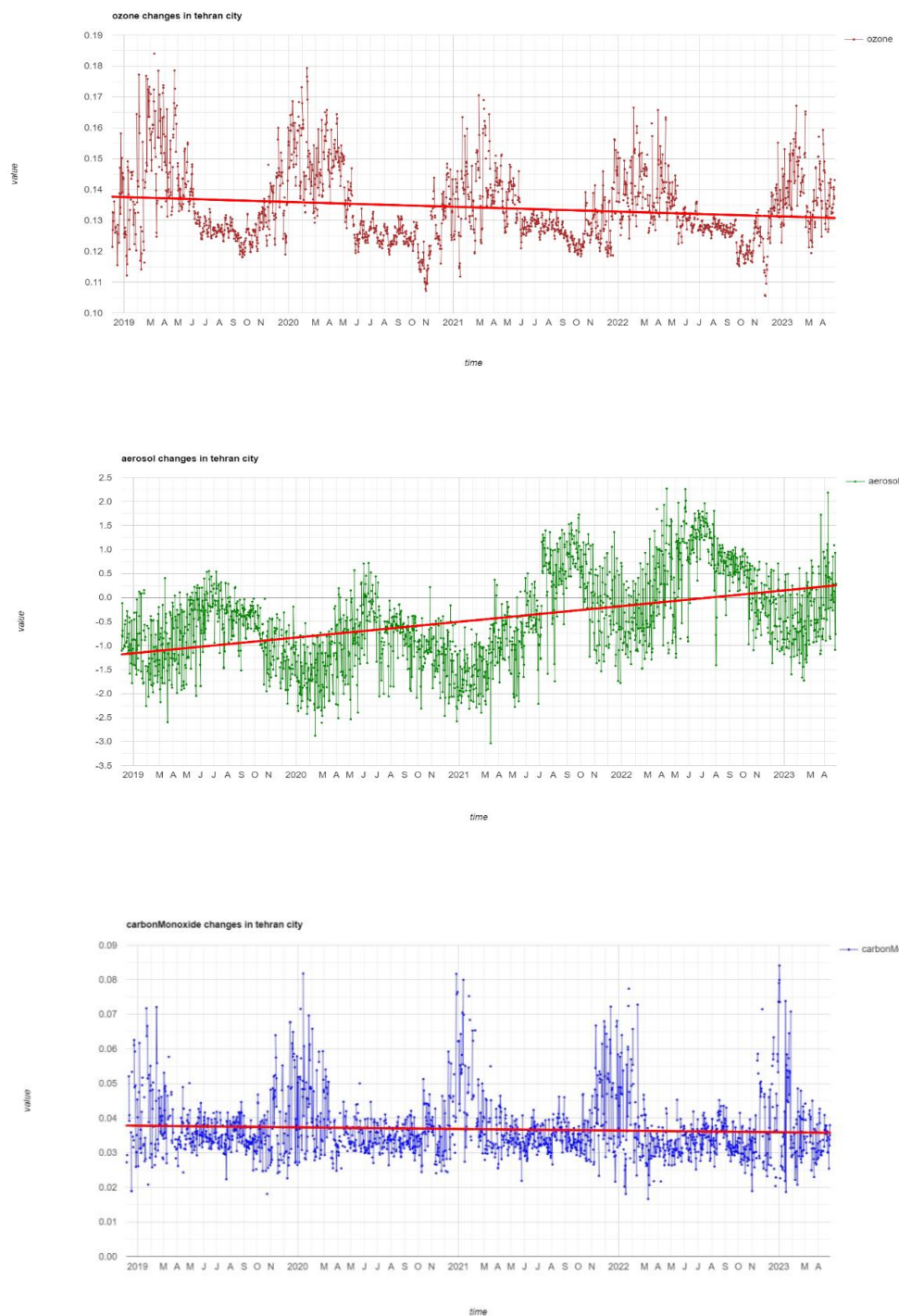
Tropomi is subsidized by the Netherlands Space Office and the European Space Agency (ESA) cooperatively, which is the only also cargo the Sentinel-5p spacecraft, it has launched 13th October 2017 into the low earth orbit. Data and methods in wavelength bands between the ultraviolet and the shortwave infrared are sheltered by a space-borne spectrometer. O₃, NO₂, SO₂, bromate (BrO₃-), formaldehyde (HCHO) and water vapor (H₂O), tropospheric columns from the ultraviolet, visible and near-infrared wavelength, and CO and methane (CH₄), tropospheric columns are measured from the short-wave infrared wavelength range are measured by TROPOMI by via spectral bands from the visible, near-infrared and ultraviolet wavelength range [13].

The third largest metropolis in the Middle East region is Tehran, which is key urban center of Iran, so it has more than 8.8 million inhabitants [14]. Tehran is situated in a valley with an altitude of 1000 to 1800 meters above sea level and it is bounded from north to northeast by mountain, in addition it has placed between 35°34'N to 35°59'N latitude and 51°5'E to 51°53'E longitude [15]. Year by year, air pollution intensifies by different reasons such as growing population rate, geographical circumstances of Tehran, using of transportations, industrial actions [16,17].

In this study, all data are collected from Google Earth Engine, then data have been analyzed by Statgraphics and provided by graphs, charts and tables in next chapter. Data of three main parameters of air pollution has been collected from the end of 2018 up to the first months of 2023 in area of Tehran city.

3. Results and Discussion

It was predictable that mentioned parameters have been changed during these four years, in figure, these changing is clear. In first chart, ozone, has been decreasing year by year, amount of it in fall months is less. Athwart, aerosol has an increasing trend and growing up yearly, and maximum amount is observed in the end of spring and the first months of summer. Meanwhile, carbon monoxide has approximately a stable trend and not has significant varieties, actually in some months like December and January it has highest amount but the same as last years.



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Figure 1. Charts of three studied parameters, ozone, aerosol and carbone monoxide respectively.

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By Statgraphics, data has been evaluated and box and whiskers plots for months have been plotted in Figure 2. About ozone parameter, it is possible to say that the less changes correspond to summer months and winter months are more varied. In plot (b), variation of aerosol is shown, as it has been shown in other charts, this parameter has been changing a lot and, in summer months, variations are more totally in a year. In plot (c), carbone monoxide doesn't have many fluctuations unless winter months.

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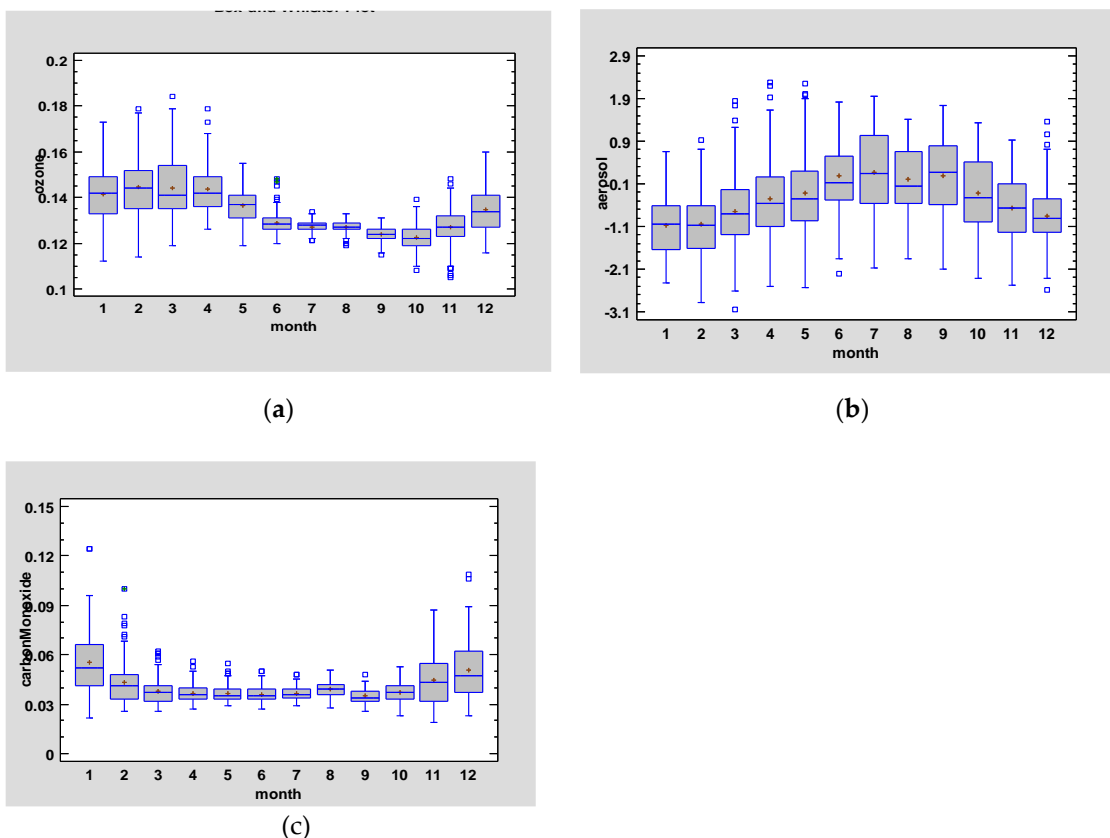


Figure 2. Box and whiskers plot for three studied parameters, ozone, aerosol and carbone monoxide respectively.

Data collected were also analyzed in some different statistical parameters, such as average, median and other stats, all numbers are mentioned in Table 1. Interquartile range has calculated for ozone, $0.015 \text{ mol } m^{-2}$, for carbon monoxide, $0.011 \text{ mol } m^{-2}$ and for aerosol $1.248 \text{ mol } m^{-2}$.

Table 1. Summary Statistics for three mentioned parameters in $\text{mol } m^{-2}$ units.

	Summary Statistics for ozone	Summary Statistics for carbon monoxide	Summary Statistics for aerosol
Average	0.134	0.041	-0.457
Median	0.131	0.037	-0.555
Standard deviation	0.012	0.012	0.925
Coeff. of variation (%)	8.963	30.177	-202.323
Minimum	0.105	0.019	-3.036
Maximum	0.184	0.124	2.270
Range	0.079	0.105	5.306
Interquartile range	0.015	0.011	1.248
Std. skewness	17.681	33.020	5.161
Std. kurtosis	7.994	53.008	-3.394

4. Conclusions

Three main parameters of air pollution of Tehran city have been studied and the results showed that aerosol has increased, ozone has decreased and CO has a stable trend. These results can be used to detected polluted months during this period and to protect human life in future. These parameters can be studied for other areas, special industrial ones, to understand the polluted areas and days of a year.

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