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Evaluation of Air Quality Status Near the Industrial Zone of Brega City Using Pollution Indicators

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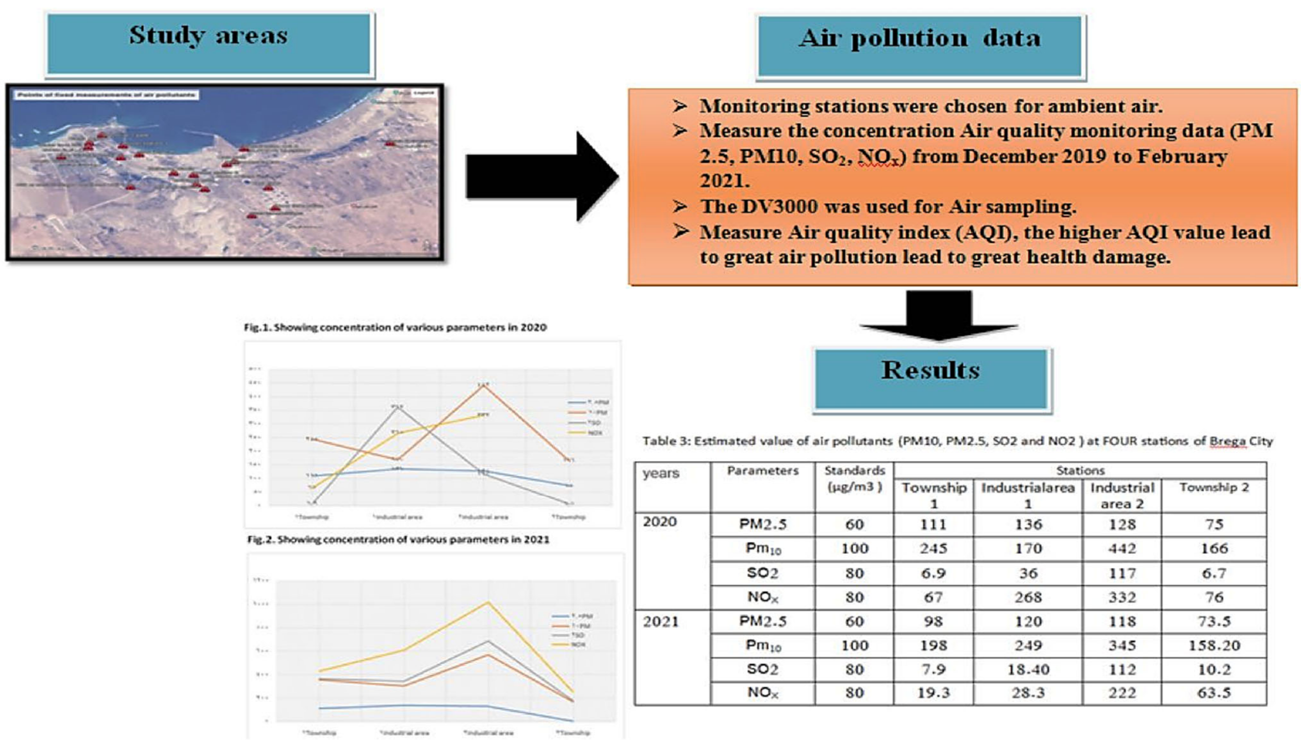
ABSTRACT

Air pollution has grown to be a serious environmental problem in recent years, having an impact on both the environment and human health. Air quality indicators were calculated using the U.S. Environmental Protection Agency procedure in order to assess the state and quality of air surrounding Brega city. The study examined the air quality during the period of February 2020 to June 2021, using an average standard of 24 hours to measure pollutants such as sulfur dioxide, nitrogen oxides, respirable suspension particles, and suspended particles in four different locations. The findings showed that the levels of air pollution for sulfur dioxide, nitrogen oxides, PM10, and PM2.5 were consistently above the allowable limit at all sampling sites and that the relative air quality index fell within the severe air pollution range.

KEYWORDS: air quality- air pollutants- air quality index (AQI)- particulate matter.

GRAPHIC ABSTRACT



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1. INTRODUCTION

Rapid industrialization worldwide, along with multiple increases in urbanization and economic expansion, has ended up resulting in a significant rise in air pollution emissions and related severe problems with air quality. [1.2] There are negative effects of air pollution on human health. [17] Air pollution has long been a concern in many nations and areas of the world, contributing to a number of issues like climate change, greenhouse gas emissions, and environmental damage.[10,13,8] It is characterized as a variation in any air ingredient from the value that would have occurred in the absence of human activity and worsens ecological conditions.[18]Air pollution has long been a concern in many nations and areas of the world, contributing to a number of issues like climate change, greenhouse gas emissions, and environmental damage.[19] Refineries in Brega emit a wide range of metals and gases along with petroleum.[9,10] The amount of harmful gasses released into the air by manufacturing smoke worsens the state of the environment and human health, and it's thought that each year, millions of tons of hazardous chemicals are emitted into the atmosphere. Particles and gases are released into the air during any combustion. These can include trace amounts of organic compounds, radioactive isotopes, soot particles, carbon monoxide, and oxides of sulfur and nitrogen. [4]

Particulate matter (PM) pollution, comprising PM2.5 (particles with aerodynamic diameter < 2.5 µm) and PM10 (particles with aerodynamic diameter ≤ 10 µm), has been the focus of attention; nevertheless, the amount of other pollutants, particularly ozone (O3), is also rapidly rising. Since its debut in the summer, O3 pollution has tended to surpass PM2.5 as the primary pollutant in major Chinese cities, according to statistics from national monitoring programs. [3,6]. These automated stations focus on six pollutants, reporting hourly over the internet: carbon monoxide (CO), sulfur dioxide (SO2), nitrogen dioxide (NO2), ozone (O3), particulate matter < 2.5 microns (PM2.5), and particle matter < 10 microns (PM10).[8,12,14]. Like many other nations, Libya experiences air pollution from sources both natural and artificial, including transportation. Lack of access to public transit leads to an increase in private automobiles, which pollute the air and fuel climate change and global warming. Libya has five refineries that are located within its borders: the Sarir refinery, the Brega refinery, the Ras Lanuf oil export port, and the Al Zawiya refinery. The primary source of pollution emissions into the atmosphere is the refining industry. Natural gas and naphtha are among the goods produced by the petrochemical sector. [16,20] Our study was carried out between February 2020 and June 2021. The study aims to evaluate air quality with pollution indicators around the Industrial Zone of Brega City.

2. MATERIALS AND METHODS

2.1. Study areas

Brega is an industrial town situated on the southeast corner of the Gulf of Sirte, at 30°26′06.0″N 19°40′01.0″E (Fig. 1). Nowadays, Marsa al-Brega, the original Brega settlement, is all but abandoned. The contemporary town of Brega, which is separated into three urban sections called Brega Area One, Brega Area Two, and the New Brega, is located about 4 km north of this settlement. North of the local airport and approximately 2 km southwest of the seaport is Brega Area One (30°24'17.95"N, 19°34'17.89"E). Brega Area Two (30°25'2.49" N and 19°38'30.91E) is located approximately 6 km east of Brega Area One, and the New Brega (30°28'51.92" N and 19°43'37.71" E) is located approximately 10 km northeast of Brega Area Two.

Fig. 1. Map of Brega City (the northern and southern Brega City)

2.2. Study sites

In order to ascertain the present and spatiotemporal aspects of ambient air pollution in Brega City, this study investigated the air pollution data that were gathered there. To measure the concentration of air quality monitoring data (PM2.5, PM10, SO2, and NOx concentrations), data from three monitoring sites in and around Brega city were used. The information utilized covered the months of February 2020 through June 2021.For ambient air, three sample locations were chosen. Brega City's three areas (First Area, Second Area and Third Area) were observed. To gather samples, 8 hours of sampling were conducted at each site.

Air sampling was conducted using the DV3000, and all parameters were examined in accordance with BTEX regulations. In order to compute the monthly moving average concentration, air was added.

2.3. Monitoring of ambient air quality

The air quality index, or AQI, calculates the ratio of the ambient air quality to the quantity of pollutants in a given area. The AQI's simple calculation and strong scientific basis are its main advantages.

Some of the factors taken into account while selecting the parameters to compute the AQI include the index's objective, the significance of the air quality indicators, and the availability of data.

The study region's air quality may be evaluated using the air quality index. The AQI may be calculated using a variety of formulae and methods. However, in this instance, the equation shown below [4, 15] has been employed in the AQI value computation.

$$AQI = \frac{1}{4} \times (IPM10/SPM10 + IPM2.5/SPM2.5 + ISO2/SSO2 + INO2/SNO2) \times 10$$

Where PM2.5, PM10, SO2, and NOx indicate the actual pollution values discovered during sampling, and SPM10, S SOx, and SNOx represent the revised ambient air quality requirements as set out by the Central Pollution Control Board of India. Following the findings' compilation, an AQI was created from each pollutant's concentration.

The five categories that comprise the AQI scale define the range of air quality and its potential health impacts (Table 1). There are five levels on the air quality index, ranging from 0 (very low) to > 100 (very high). In this study, mild air pollution was defined as having an index value between 26 and 50, while clean air was defined as having an index value between 0 and 25. The pollutant with the highest AQI number was added up to calculate the total AQI for a particular location. A higher AQI score indicates more air pollution and the ensuing health impacts.

Table 1. Interpretation of the air quality index (AQI) values

Value	Description	Health Effects
0-25	pure air	None or very little impact on health
26-50	minimal air pollution	Potential cardiac or respiratory effects in the most susceptible people
51-75	Mild air pollution	Growing probability of respiratory and cardiovascular disorders and symptoms
76-100	severe air pollution	worsening of lung or cardiac conditions. higher chance of mortality in kids. (Lung and heart problems); heightened consequences among the broader populace
>100	extreme pollution of the air	severe worsening of lung or heart illness; increased chance of dying young. significant risk of cardiopulmonary symptoms in the general public

3. RESULTS AND DISCUSSION

In the four Brega City areas that were chosen for this study, the concentration levels of air contaminants such as NOx, SO2, PM2.5, and PM10 were found to range from low to very high for both years. (Figs. 2 and 3, Tables 1 and 2) The highest recorded PM2.5 value for 2020 was discovered to be 80.9µg/m3 at Industrial Area 2. In 2021, data and the lowest value were recorded at 73.5 µg/m3 in residential area 2. All PM2.5 values at the chosen stations were higher than the allowable limit of 60 µg/m3 for the two years of study.

Similarly, for both of the two years under study, PM10 was found at all of the chosen stations to be above the allowable levels (100 µg/m3). In 2020, the highest recorded value of PM10 was 442 µg/m3 at Industrial Area 2, while in 2021, the lowest recorded value was 158.20 µg/m3 at Residential Area 2. Strong and medium-sized winds produce localized disturbances and turbulent environments, which lead to hazy conditions and dust storms, which increase the size of the particles. 19,21[. Furthermore, SO2 was noted to be higher than the allowed thresholds (80µg/m3) The highest recorded value was 117µg/m3 at Industrial Area 2 in 2020, while the lowest recorded value was 112 mg/m3 at the same location in 2021. Similarly, NOX was also observed beyond the permissible limits (80µg/m3). The maximum value was found at 332µg/m3 at Industrial Area 2 in year 2020, and the minimum value was observed at 222 mg/m3 at Industrial Area 2 in year 2021. A limit of 80 µg/m3 was observed for SO2 and NOx concentrations at Residential Area 1 and Residential Area 2 in the study period. Our findings here are consistent with earlier research evaluating the effects of upcoming emissions changes driven by NOx emission reduction. (19,22,23,24)

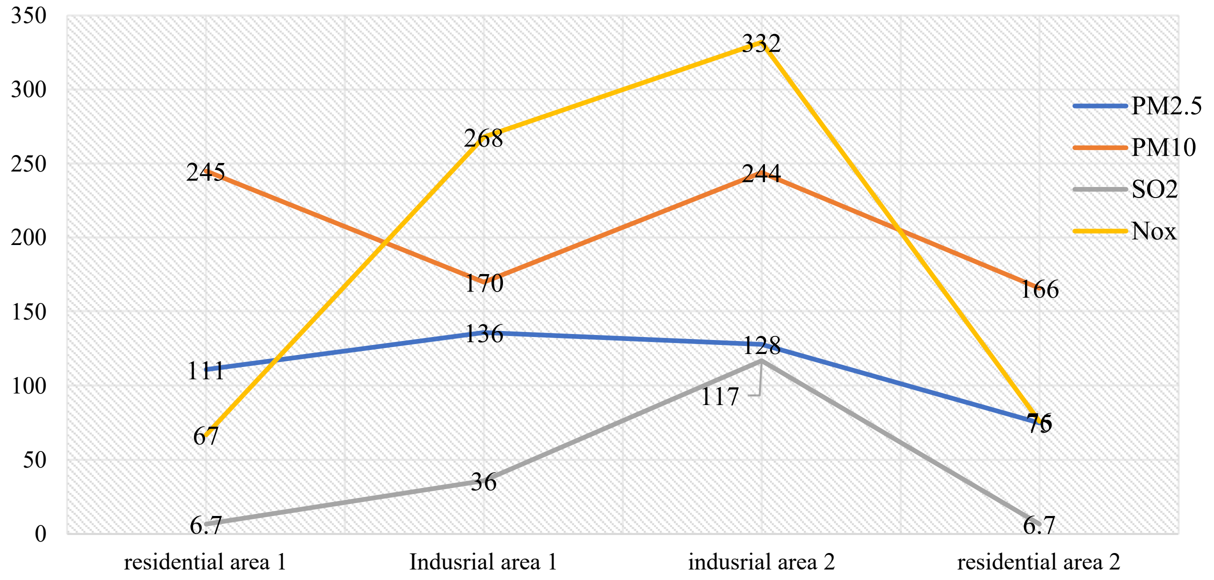

Fig. 2. Showing concentration of parameters (PM2.5, NO2, SO2, and PM10) in 2020

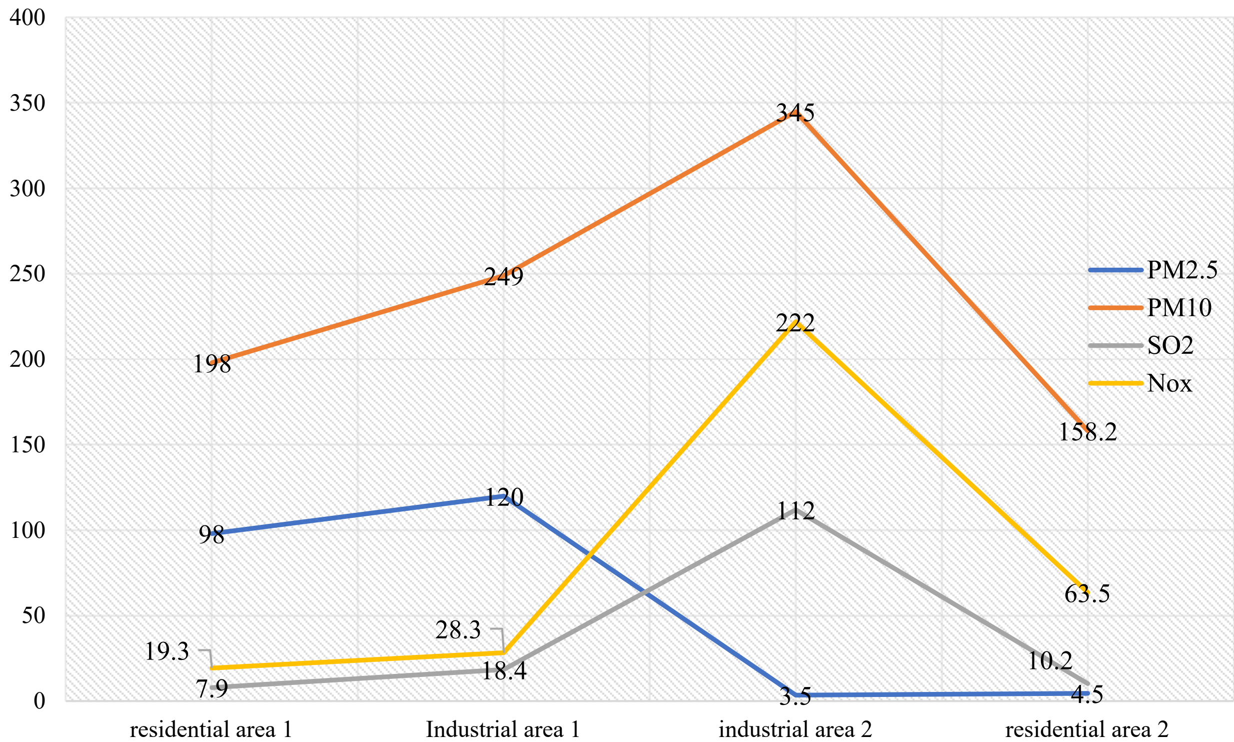

Fig. 3. Showing concentration of (PM10, PM2.5, SO2 and NO2) parameters in 2021

Table 2: Estimated value of our sites measuring air pollutants (PM_{10}, $PM_{2.5}$, SO_2, and NOx) of Brega City

years	Parameters	Standards (µg/m3)	Stations			
			residential area 1	Industrial area 1	Industrial area 2	residential area 2
2020	$PM_{2.5}$	60	111	136	128	75
	Pm_{10}	100	245	170	442	166
	SO_2	80	6.9	36	117	6.7
	NO_X	80	67	268	332	76
2021	$PM_{2.5}$	60	98	120	118	73.5
	Pm_{10}	100	198	249	345	158.20
	SO_2	80	7.9	18.40	112	10.2
	NO_X	80	19.3	28.3	222	63.5

Standards Source: Ministry of Environment and Forest, New Delhi, Notification, Dated 16th Nov, 2009

3.1. Index of Air Quality (AQI)

The AQI score for the ambient quality of the air monitoring data in Al Bubrah City was converted to a value during the study period (Table 2, 5). In 2020 and 2021, the level of air pollution was found to be severe and more common in industrial areas than in residential areas. In 2020, the level of pollution was high in both residential and industrial areas, with the AQI value in residential areas falling between the limits of 117.44 and 130.59 and in industrial areas between 294.15 and 304.14. While the amount of air pollution in industrial regions was high in 2021, only the AQI value was found to be within the range of (126.28-239.78), and the AQI value in residential areas with high air pollution was found to be in the range of (98.20-98.80).

Table 3: Category of air quality determined by AQI of four locations of Brega City in 2020

Stations	AQI	AQI Category
residential area.1	130.59	Severe air pollution
Industrial area 1	294.15	Severe air pollution
Industrial area 2	304.14	Severe air pollution
residential arean.2	117.44	Severe air pollution

Table 4: Category of air quality determined by AQI of four locations in Brega City in 2021

Stations	AQI	AQI Category
residential area 1	98.80	Heavy air pollution
Industrial area 1	126.82	Severe air pollution
Industrial area 2	239.78	Severe air pollution
residential area 2	93.20	Heavy air pollution

4. CONCLUSIONS

Al Brega City has measured air pollution and air quality, and the outcomes show that PM2.5 and PM10 are always outside the allowed limit everywhere. However, nitrogen oxides and sulfur dioxide were consistently below the allowed limit in residential areas and outside the allowed limit in industrial zones. It was discovered that relative AQI accurately represented potential extreme air pollution that could worsen existing health and environmental issues.

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