Journal of Applied Science and Environmental Studies
JASES
http://revues.imist.ma/index.php?journal=jases

IMPACT OF INDUSTRIAL ATMOSPHERIC EMISSIONS (CO_2) ON AMBIENT AIR QUALITY IN THE REGION OF ARZEW, ALGERIA

S. NAILI [1*], A. MORSLI [1]

[1]Department of Chemical Engineering, Faculty of Chemistry, University of Sciences and Techniques of Oran - Mohamed Boudiaf, El Mnaoua, BP 1505, Bir El Djir 31000, Oran, Algeria

* Corresponding author. E-mail address: nailisaid66@gmail.com

Received 15 July 2021; Revised 28 November, Accepted 20 December 2021

Keywords
Air pollution, Air quality, Carbon dioxide, Industrial activities

Abstract
The main objectives were to identify the source and assess the level of air pollution, in accordance with national and international legislation and standards relating to ambient air quality. This work focused on the impact of carbon dioxide (CO_2) emissions generated by industrial activities of petroleum refining, liquefied natural gas processing and petrochemicals, on the quality of ambient air in the region of Arzew, Algeria in 2017. The study revealed that the average annual CO_2 concentration did not exceed the limit value recommended by the European standard EN 13779. This study also demonstrated that the CO_2 content levels depended on the emission rates industrial and weather seasons, peaking in summer mainly due to relatively stable weather conditions.

1. Introduction

Air pollution is one of the most dangerous environmental problems affecting the health of people in various ways. Long-term exposure to high levels of air pollution leads to cardiovascular, respiratory, reproductive and neurological health problems and results in the deaths of many people around the world, especially children. The emission of gaseous pollutants into the atmosphere degrades the quality of the ambient air, resulting in fog, reduced visibility and damage to materials of great cultural value such as statues and monuments. This degradation in the quality of the air we breathe is called pollution, harmful gases in the atmosphere exceeding their natural limit. Atmospheric pollution is the result of multiple anthropogenic factors, particularly industrial ones. Air pollution, especially emissions from the oil and gas industry, including mining, refining, storage, transport between different storage facilities and refueling, is complex [1,2]. Air pollution is a widespread health problem associated with respiratory symptoms and may contribute to the development of chronic obstructive pulmonary disease with increased sensitivity in children, older adults, and

people with heart and lung disease [3,4]. Air pollution affects the integrity of humans and ecosystems depending on the dose and time of exposure, and is caused by stationary and mobile sources from multiple sectors of human activity such as industry, residential sector, transport, agriculture and can manifest itself for example by the presence of CO_2 in the atmosphere [5]. The impact of increasing concentrations of CO_2 [6-9] in the atmosphere on the biosphere includes changes in species range, seasonal activities, migration patterns and abundances, as well as changes in species. interactions between species. The rapidly growing trend of hydrocarbon-related industries is a potential driver of air pollution and its negative impact on public health and the environment is a serious problem that cannot be underestimated [10,11].

2. Experimental

2.1. Description of the sampling site

This study was carried out in 2017 in the industrial zone of Arzew, in the Oran region, in the north-west of Algeria (geographical coordinates: Latitude - 35 ° 47'57.81 'N and Longitude - 0 ° 14'33.85 'W), at an altitude of 54 meters, as shown in Figure 1. Covering an area of 2,700 hectares, this area stretches over 12 km along Arzew Bay. The industrial hub of Arzew is a strategic location of choice for industrial activities related to hydrocarbons such as the processing and liquefaction of natural gas, the refining of crude oil and petrochemicals [1,2]. The industrial zone of Arzew, located on the edge of the coast, is influenced by the Mediterranean climate, with an alternation of two seasons. The summer period, the longest is hot, generally dry. On the other hand, the winter period is cold with irregular and sometimes heavy precipitation but of short duration [12].

Figure 1. Geographical location of the measurement site.

2.2. Meteorological parameters at the sampling site

The levels of this type of pollution depend on meteorological conditions such as the stability of the atmospheric boundary layer, wind speed and direction, temperature, humidity, turbulence, precipitation, topography… etc. [13]. These factors control the transport, distribution and impacts

of these pollutants on ambient air quality. Some of the parameters that characterize the climate, such as wind speed, wind direction, humidity, precipitation and temperature in the study area were examined in this study. These parameters were evaluated by the Arzew weather station (National Meteorological Office) during the measurement period. The distance between the weather station and the air quality monitoring site is 900 m.

Table 1. Seasonal averages of meteorological parameters in 2017

Seasons	Temperature (° C)	Wind speed (m/s)	Wind direction (frequency)	Humidity (%)	Rainfall (mm)
Winter	17	20.6	NNE	73	66
Spring	24.7	13.9	NE	59	7.5
Summer	30.7	11.6	NE	58	3.7
Fall	20.7	10.6	NE	60	25.7

3.2. Sampling and measurement methods

The ambient air quality monitoring system was manufactured by Environment S.A. This system is composed of several transducers and analyzers using various instrumentation techniques. The measuring station operated 24 hours a day for 12 months. Sampling and analysis was done automatically and the data was then transferred to the data station. CO_2 is measured by the infrared correlation method using the CO12M analyzer model. The metrology is based on the principle of infrared absorption, according to the Beer-Lambert law. The concentration of CO_2 in the CO_2 sample is determined by measuring the amount of infrared light absorbed by the sample gas. The absorption spectrum of CO_2 is characterized by a band around 2141 cm^{-1}. The standardized ISO 4224 measurement method by the CO12M analyzer allows continuous measurement of the CO_2 concentration in ambient air.

4. Results and discussions

Figure 2 shows the monthly evolution of the CO_2 content of the atmosphere in the industrial zone of Arzew during the year 2017. The highest monthly average concentrations were observed during July (436 mg/m^3), August (508 mg/m^3) and September (402 mg/m^3) The high concentrations recorded during the summer season are mainly due to unfavorable meteorological conditions for the dispersion of polluting elements due to scarcity of precipitation and weak winds as well as to the CO_2 emission intensity factor resulting from industrial complexes. The increase in average monthly CO_2 concentrations recorded is mainly explained by certain malfunctions in industrial treatment processes, whether due to the transformation and liquefaction of gas, oil refining or petrochemical synthesis, with a correlation of some weather parameters already mentioned.

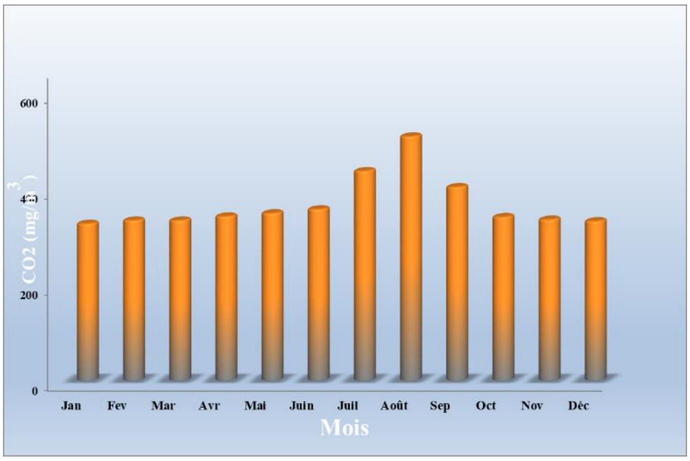

Figure 2: Average monthly changes in CO_2 content in 2017.

Figure 3 shows the seasonal variation of the carbon dioxide content in ambient air at the industrial hub of Arzew in 2017. The CO_2 concentration reached a very high level during the summer season (449 mg/m^3), while that the concentrations during the other seasons were relatively low of the order of 335 mg/m^3 in the fall, 348 mg/m^3 in the spring and 331 mg/m^3 in the winter. The high concentrations recorded during the summer, especially in the months of August (508 mg/m^3) and July (436 mg/m^3), are mainly due to increases in the intensity of CO_2 gas emissions in the atmosphere resulting from emissions from industrial activities, in particular those related to the sector of transformation and liquefaction of natural gas (LNG), in addition to the dry season which coincides with the local summer, where this season is characterized by reduced rainfall and relatively weak winds (an average 11.6 m/s) and infrequent with the high temperature (an average 30.7 °C) thus promoting stagnation and saturation of the air by concentrations of CO_2 in the atmosphere.

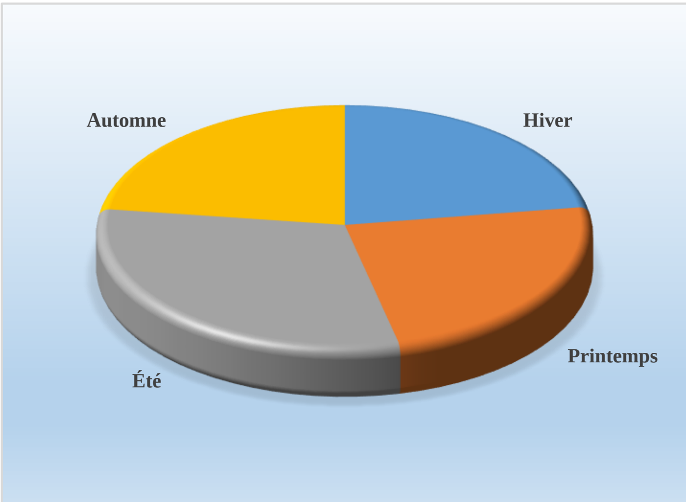

Figure 3: Average seasonal variations in CO_2 content in 2017.

Figure 4 shows the daily variation of the CO_2 content in ambient air. The curves of the daily variation of the average CO_2 concentrations were characterized by a high concentration in the summer months, in particular the days of August and July. Daily average CO_2 concentrations reached several maximum concentrations (12 times), where they exceeded 500 mg/m^3 during the month of August.

Profiles of the observed daily CO_2 averages during the fall months were relatively low (ranged from 355 mg/m^3 to 327 mg/m^3 daily mean), while the lowest CO_2 concentration values were recorded during the fall months. days in the winter months, especially in January (maximum of 334 mg/m^3 on a daily average).

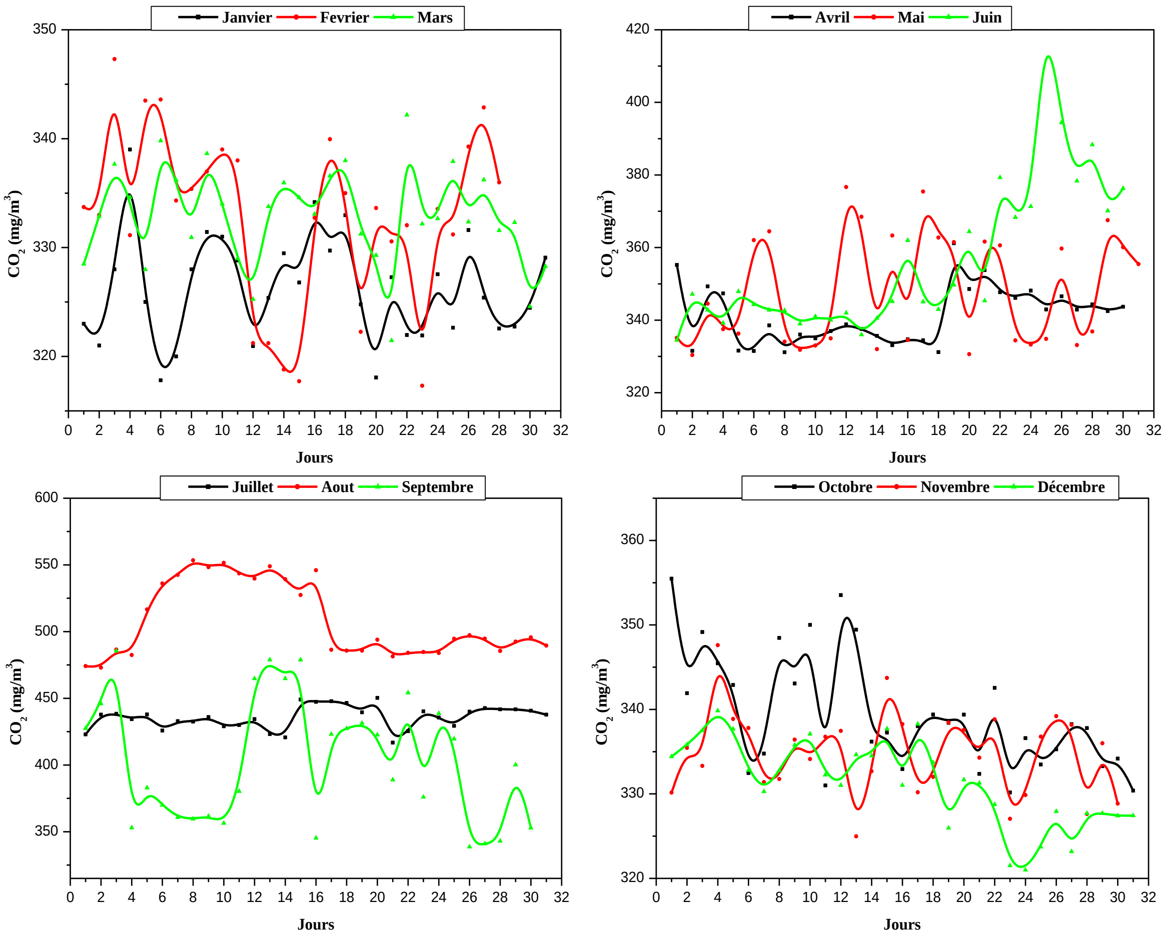

Figure 4 : Variations journalières moyennes de la teneur en CO_2 en 2017.

The results of seasonal, monthly and daily variations in CO_2 concentrations, measured by the air quality monitoring station during the measurement period, indicating a slight variation in CO_2 concentrations at the measurement site, at the exception of the summer season where very high concentrations were recorded during most days of summer. This increase is significant on the measurement site, which is close to the sources of emissions, whether point (discharge of pollutants from chimneys or flares) or fugitive (accidental leaks from pipes or storage) represented in the activities. natural gas processing and petroleum and petrochemical refining industries [1,2,14]. It is stronger during the months of July, August and September and much less accentuated during the other months. In fact, the highest concentrations coincided with the months of the summer season. This dry season is characterized by low wind speed and rarely by precipitation, which promotes stagnation and saturation of the air with concentrations of carbon dioxide. The increase in average daily CO_2 concentrations recorded, especially in August, can be explained by the increase in the intensity of CO_2 emissions into the atmosphere. This situation is mainly linked to certain malfunctions in industrial treatment processes, whether due to the transformation and liquefaction

of gas, oil refining or petrochemical synthesis, with a correlation of certain meteorological parameters [1,2,14]. Under these meteorological conditions, CO_2 gas emissions, in particular those resulting from the intensity of industrial emissions, are significant and accumulate in a thin atmospheric layer generating high levels in the ambient air.

5. Conclusion

The results presented in this study revealed a seasonal behavior of the CO_2 concentration, with maximum values in summer, especially in August, and reference values for the rest of the year. This characteristic is mainly linked to the drought period in the Arzew region. The high concentration of carbon dioxide during the summer season in the Arzew industrial zone is mainly due to the weather conditions in this region with high air emissions from the processing of hydrocarbons. In general, the average annual carbon dioxide content measured at the platform of the Arzew industrial zone in 2017 was relatively low (around 366 mg / m3) compared to the indicative value (400 mg/m^3) recommended by European standard EN 13779. Thus, we can conclude that the ambient air quality in the industrial center of Arzew is superior to the air quality objective setting the CO_2 content, in accordance with standard EN 13779 This result considerably reduces the risks to the health of the population with regard to respiratory diseases and other problems caused by air pollution in industrial settings.

Acknowledgments

Les auteurs remercient les responsables du département de la surveillance de la pollution atmosphérique d'avoir fourni toutes les données et informations sur la qualité de l'air ambiant au niveau de la plateforme de la zone industrielle d'Arzew.

References

1. S. Naili, A. Morsli, Impact of industrial atmospheric emissions on ambient air quality in Arzew area, Algeria, **Maghrebian Journal of Pure and Applied Science**. 17 (2021) 31- 36.
2. S. Naili, A. Morsli, Impact of industrial atmospheric emissions on ambient air quality in the region of Arzew (north-western Algeria), **International Journal of Environmental Studies**. 77 (2020) 1-13.
3. T. Gotschi, J. Heinrich, J. Sunyer, N. Kunzli, Long term effects of ambient air pollution on lung function: a review, **Epidemiology**. 19 (2008) 690-701.
4. B Brunekreef, Air pollution and health effects, **J Expo Sci Environ Epidemiol**, 17 (2007) 61-65.
5. C. Ren, S. Tong, Health effects of ambient air pollution, **Environmental Health**. 7 (2008) 11-56.
6. E. Assareh, M. Nedaei, A metaheuristic approach to forecast the global carbon dioxide emissions, **International Journal of Environmental Studies**. 75 (2017) 99-120.
7. I. Niknia, M. Yaghoubi, R. Hessami, A novel experimental method to find dust deposition effect on the performance of parabolic trough solar collectors, **International Journal of Environmental Studies.** 69 (2012) 233-252.
8. J. Gomes, J. Nascimento, H. Rodrigues, Developing a local carbon dioxide emissions inventory based on energy demand and waste production, **International Journal of Environmental Studies**. 64 (2012) 347-355.

9. M. Sengul, C.G. Francis, M. Elkadi, A.E. Pillay, The contribution of CO_2 emissions to environmental stress in the Middle East: challenges and potential solutions, **International Journal of Environmental Studies**. 66 (2014) 705-722.
10. L. Matejicek, Spatial modelling of air pollution in urban areas with GIS: A case study on integrated database development, **Advances in Geosciences**. 4 (2005) 63-68.
11. S. Hina, M. Zahid, I.H. Baloch, T.S. Pasha, Environmental impacts of Quaid-e Azam industrial estate on neighboring residential area in Lahore (Pakistan), **Water Resource and Protection**. 3 (2011) 182–185.
12. M. Kacemi, Protection du littoral en Algérie entre politiques et pouvoirs locaux : le cas du pôle industriel d'Arzew (Oran- Algérie), **Revue en sciences de l'environnement**.17 (2006) 3.
13. N.L. Seaman, Meteorological modeling for air-quality assessments, **Atmospheric Environment**. 34 (2000) 2231-2259.
14. B. Medjahed, S, Naili, M. Bouzit, Experimental study of the impact of pollutants on air quality in the urban cite, **Journal of Materials and Environmental Science**. 8 (2017)144-153.