



Assessing Air Quality in Industrial, Urban and Transport Areas in Long Xuyen City, An Giang Province, Vietnam

Nguyen Thanh Giao¹

¹College of Environment and Natural Resources, Can Tho University, Can Tho 900000, Vietnam

Corresponding Author Email: ntgiao@ctu.edu.vn

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Abstract

This paper presents an assessment of the current state of the air quality affected by industrial, urban and transportation activities in Long Xuyen city, An Giang province in the period 2016-2019. Air quality monitoring data includes temperature, noise, total suspended dust (TSP), nitrite oxide (NO₂), sulfur dioxide (SO₂), carbon monoxide (CO), ozone (O₃), ammonia gas (NH₃) and hydrogen sulfur gas (H₂S) were provided by the Department of Natural Resources and Environment of An Giang province. The results showed that the quality of the air environment in industrial zones, urban areas and transport sites were within the permitted standards of Vietnam. However, the indicators of TSP, NO₂, CO, SO₂ tended to increase if it is not well controlled, which can consequently affect the environment and human health. The environmental managers need to strengthen monitoring of air environment quality so that there are timely solutions to overcome pollution problems to ensure public health. This study recommends that the relevant agency should measure acetaldehydes, and volatile organic carbons since these gases are toxic and regularly emitted.

1. Introduction

Long Xuyen city, An Giang province is located on the banks of the Hau River, with geographical coordinates: 10018'-10026' North latitude and 105021'-105030' East longitude. The Northwest borders on Chau Thanh district, the border line is 12,446 km long; The Northeast borders on Cho Moi district; To the west, it borders on Thoai Son district with a border line length of 10,054 km; and to the South by Thot Not district of Can Tho city. Long Xuyen city with an area of 115.4 km², 1950 km south of Hanoi capital, 189 km southwest of Ho Chi Minh city, 45 km from the Cambodian border. There are many sources of air pollution in Long Xuyen. Transport activities generate air pollution. Due to being the second largest economic region in the Mekong Delta, Long Xuyen city is a very bustling and dynamic place, and Long Xuyen city is densely populated and densely packed. In particular, every day, the volume of cars entering and leaving the city is very large and emits a huge amount of smoke and dust into the air, affecting the human health environment, especially in crowded traffic points such as intersections, bus stations or ferry terminals, the amount of smoke and dust causing pollution in these areas is always at an alarming level. Industrial development activities also pollute the air environment. Due to the high circulation of vehicles from the transportation of production and materials, the exhaust gas emitted from vehicles in the industrial park also contributes to the pollution of the air or materials when transporting is not properly shielded. In addition to the two main sources mentioned above, Long Xuyen city also has other sources

of polluting gas emissions such as: emissions from Long Xuyen landfill, emissions from production activities, waste incineration [1-3].

Air pollution has a huge impact on human health, especially on the respiratory tract. When the air is polluted, human health is degraded, the aging process in the body is accelerated, lung function is impaired, asthma, cough, rhinitis, pharyngitis, bronchitis management, nervous breakdown, cardiovascular and human longevity [4]. The most dangerous is possibly causing lung cancer. In addition, the polluted air environment also significantly affects the life and development of the living creatures, both animal and plant life [5]. The extent to which air pollution affects each individual depends on health status, concentration, type of pollutant and time of exposure to the polluted environment [6]. The study was conducted to assess the current situation of air quality in Long Xuyen city, An Giang province. Research results provide important information for the local environmental regulators.

2. Methodology

Air quality monitoring data in industrial areas, urban areas and transportation sites in Long Xuyen city, An Giang province including temperature, noise, total suspended dust (TSP), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), carbon monoxide (CO), ozone (O₃), ammonia (NH₃) and hydrogen sulfur gas (H₂S) were collected over the years 2016-2019. The frequency of air sample collection was two times per year which were in March and September. The data was obtained from the Department of Natural Resources and Environment of An Giang province. The sample collection and methods for analysis were presented in Table 1. For ambient air quality data, data are presented as mean ± standard deviation (TB ± SD). Differences between sampling sites determined by analysis of one factor variance (ANOVA) and a significant 5% difference between each site were determined using the Duncan test using IBM SPSS statistics software for Windows, Version 19.0 (IBM Corp., Armonk, NY, USA).

Table 1. Air quality parameters and analytical methods

No.	Parameters	Methods for sample collection and analysis
1	TSP	TCVN 5067:1995
2	SO ₂	TCVN 5971:1995
3	NO ₂	TCVN 6137:2009
4	CO	HDCV-QTMT-06
5	H ₂ S	MASA Method 701
6	NH ₃	MASA Method 401
7	HF	MASA Method 809
8	C _n H _m	NIOSH Method 1500
9	O ₃	MASA Method 411

Notes: MASA: Method of Air sampling and analysis; NIOSH: National Institute for Occupational Safety and Health

3. Results and discussion

3.1 Air quality in the industrial areas

In the period 2016-2019, the temperature at the affected location from the My Quy industrial park ranged from 29-35.6°C, the heat generated in the industrial park from the fuel burning process, the production technology, heat transfer from building structures. The highest temperature was in June 2019 (35.6°C) and lowest in March 2016 (29°C). Monitoring results showed that the measured noise value at My Quy Industrial Park in 3 years (for example, 2016-2019) ranged from 64 ± 0.71-67.5 ± 2.12 dBA (Figure 1). Noise had the highest value in 2016 and tended to decrease gradually through 2016 and 2019, all meeting the permitted standards according to QCVN 26: 2010/BTNMT (70 dBA) [7].

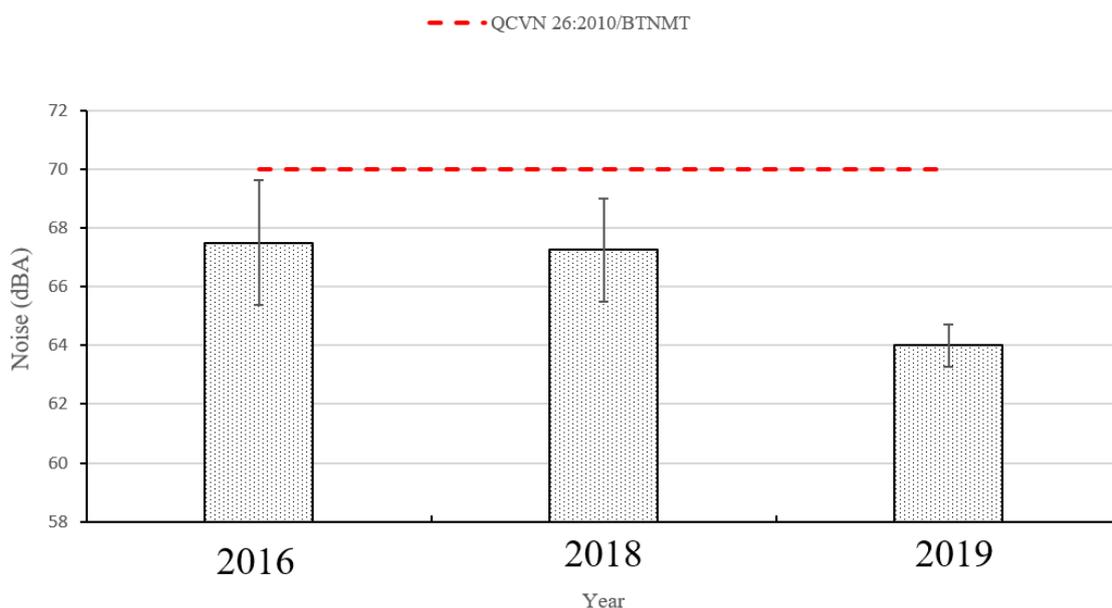


Figure 1. Noise in the air in the industrial areas for the period of 2016-2019

The concentration of total suspended dust measured in the industrial park in the period 2016-2019 ranged from $0.18-0.21 \pm 0.1 \text{ mg/m}^3$ (Figure 2). In 2019, the value of total suspended dust increased compared to 2016 and 2018, and tended to increase gradually over years. In general, they all meet the permitted standards according to QCVN 05: 2013/BTNMT (0.3 mg/m^3) [8]. TSP tends to increase mainly due to the high circulation of vehicles in industrial zones, when transporting materials is not properly shielded, causing dust generation into the environment, affecting air quality.

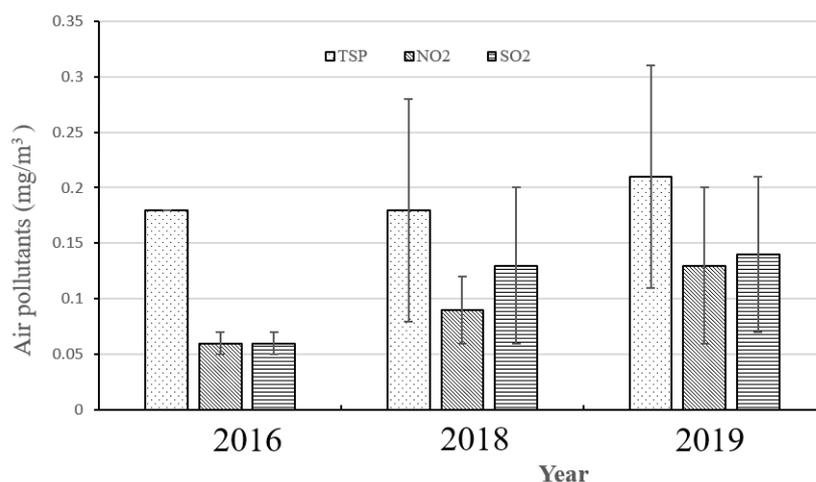


Figure 2. TSP, NO₂, SO₂ in the air in the industrial areas for the period of 2016-2019

The measured NO₂ concentration in the industrial area ranged from $0.06 \pm 0.01-0.13 \pm 0.07 \text{ mg/m}^3$ (Figure 2), tended to increase over the years. The values all meet the allowed standards according to QCVN 05: 2013/BTNMT (0.2 mg/m^3) [8]. The NO₂ concentration tended to increase, which can lead to the deterioration of the air environment quality, negatively affecting the health of workers inside and near industrial zones. The amount of SO₂ measured in My Quy industrial park in the period 2016-2019 ranged from $0.06 \pm 0.01-0.14 \pm 0.07 \text{ mg/m}^3$ (Figure 2). Similar to NO₂, SO₂ tended to increase over the years, but still meets the permitted standards according to QCVN 05: 2013/BTNMT (0.35 mg/m^3) [8]. SO₂ is produced from the burning of

coal and oil, gas, and increasingly affects the air environment in Long Xuyen city, adversely affecting health and ecosystem. Especially for humans, it causes symptoms such as chest tightness, headache, vomiting, death from respiratory disease. Therefore, it is necessary to have long-term remedial measures to avoid causing pressing problems from the industrial environment. The amount of CO observed in the industrial area ranged from 4.22 ± 1.77 - 5.59 ± 0.55 mg/m³ (Figure 3) in the period 2016-2019. In 2016, the CO value decreased compared to 2016, but tended to increase in 2019, in general, the CO concentration met the permitted standards according to QCVN 05: 2013/BTNMT (30 mg/m³) [8]. CO arises from the burning of carbon-containing composites, and accounts for the largest proportion in the air pollution. CO can quickly be converted to CO₂ under the influence of sunlight.

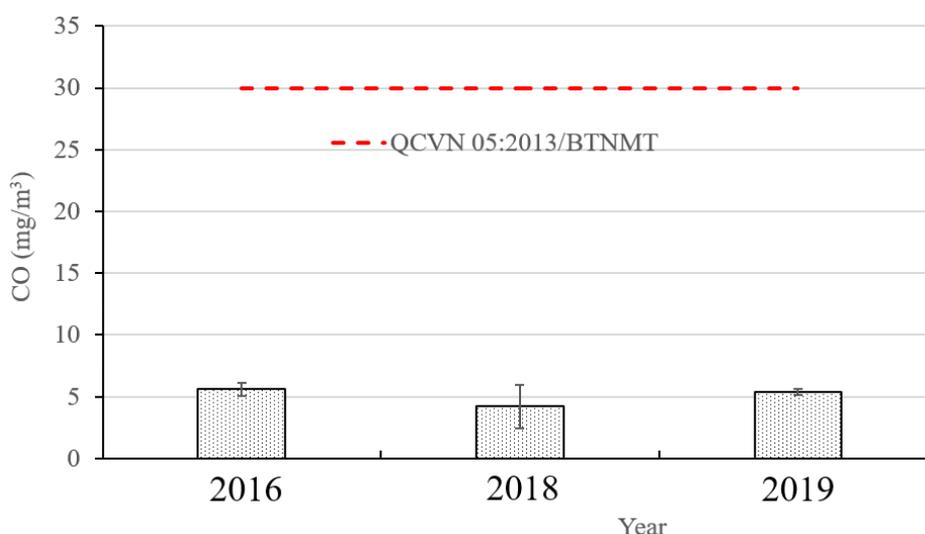


Figure 3. CO in the air the industrial areas for the period of 2016-2019

O₃ gas is produced and lost very quickly, it only stays in the atmosphere for a few minutes. Monitoring results of O₃ in the air at My Quy industrial park ranged from $0-0.01 \pm 0.02$ mg/m³ (Figure 4), within the allowable range according to QCVN 05: 2013/BTNMT (0.2 mg/m³) [8]. Ozone is harmful to fiber materials, especially cotton, nylon, man-made fibers and dyes, adversely affecting human health. O₃ was not detected in the My Quy industrial area, but with its harmful effects, it is necessary to have more strict management.

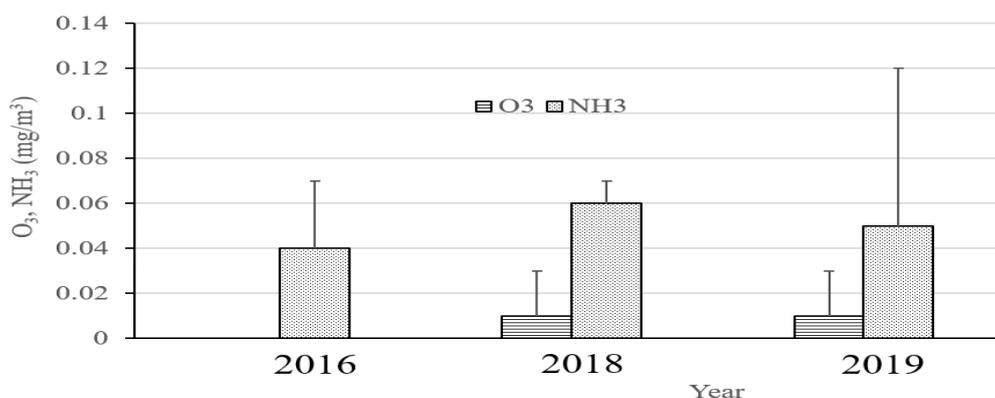


Figure 4. O₃ and NH₃ in air in the industrial areas for the period of 2016-2019

The monitoring results of NH₃ and H₂S in My Quy industrial zone showed that the values were within the allowable range according to QCVN 06: 2009/BTNMT [9]. NH₃ ranged from 0.04

$\pm 0.03-0.05 \pm 0.07 \text{ mg/m}^3$ (Figure 4). Particularly, H_2S was not detected in the air in the 2019-2019 period. In general, the quality of the air environment in the area affected by the industrial park in 2016-2019 has not shown any signs of serious pollution.

3.2 Air quality in the urban areas

The temperature monitoring results in the period 2016-2019 showed that the highest temperature in September 2016 (34.7°C), the lowest in March 2019 (30.1°C), is suitable for human life. Noise in urban areas in Long Xuyen city ranged from 72.25 ± 6.72 to 74.25 ± 26.26 dBA (Figure 5), exceeding the permitted threshold according to QCVN 26: 2010/BTNMT (70 dBA) [7] from 1.03 - 1.06 times. The cause of high noise was affected by production, business and heavy traffic. Noise reduces hearing loss and causes hearing problems.

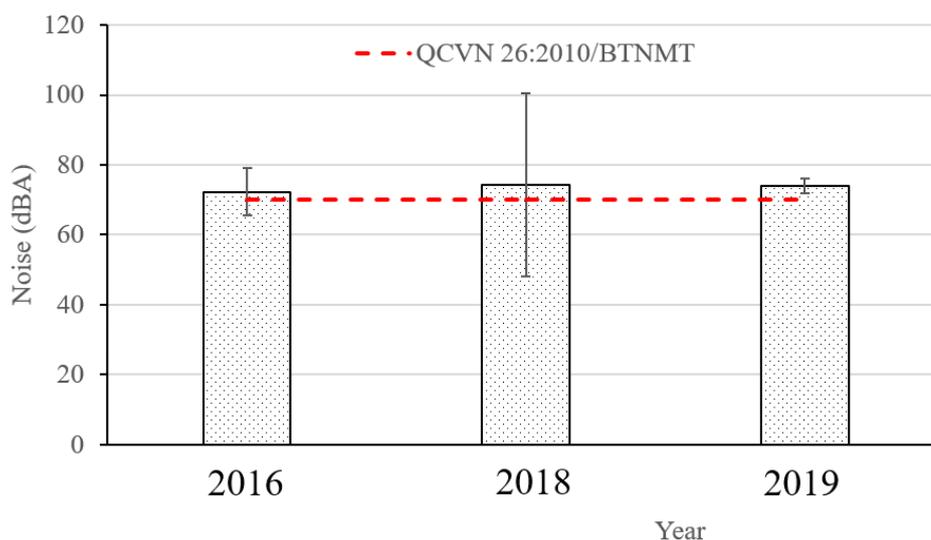


Figure 5. Noise in the air in urban area for the period of 2016-2019

The CO value over the monitoring time ranged from $4.93 \pm 1.61-9.63 \pm 4.68 \text{ mg/m}^3$ (Figure 6), all reaching the allowable limit according to QCVN 05: 2013/BTNMT [8]. If a large amount of CO enters the atmosphere will increase CO in the atmosphere, CO can be harmful to human health, because CO affects the lungs and reduces oxygen in the blood, affecting the nerve center, impaired sensory and vision [10].

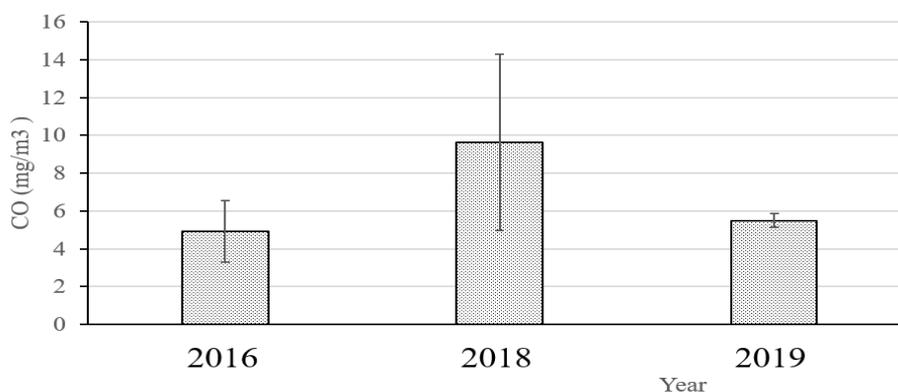


Figure 6. CO in the air in urban area for the period of 2016-2019

The average total suspended dust content over the years ranged from $0.161 \pm 0.01-0.24 \pm 0.13$ (mg/m^3), all of which did not exceed QCVN 05: 2013/BTNMT (0.3 mg/m^3) [8] (Figure 7). Although it tended to increase in 2019, it was still within the allowed standards, and does not

affect the lives of people around. The average NO_2 in urban areas over the years of observation ranged from 0.05 ± 0.03 - $0.14 \pm 0.1 \text{ mg/m}^3$ (Figure 7). For three consecutive years, NO_2 concentration has always been within the allowable range of QCVN 05: 2013/BTNMT (0.2 mg/m^3) [8]. However, NO_2 should be managed well within the limits since NO_2 is toxic when exposed to a concentration of 15 to 50 ppm within a few hours is dangerous to the lungs, heart and liver, so it can be said that the air in urban areas that are polluted when NO_2 will cause harmful effects to human health [11]. SO_2 fluctuated in 2016-2019 from 0.057 ± 0.04 - $0.16 \pm 0.11 \text{ mg/m}^3$, meeting QCVN 05: 2013/BTNMT (0.35 mg/m^3) [8] (Figure 7). SO_2 is produced by burning sulfur-containing materials. The amount of SO_2 generated depends on the temperature and oxygen in the combustion process [10], the impact of SO_2 is damage and reduce the life of fabric, nylon, rayon, leather and paper and even fades paintings [11].

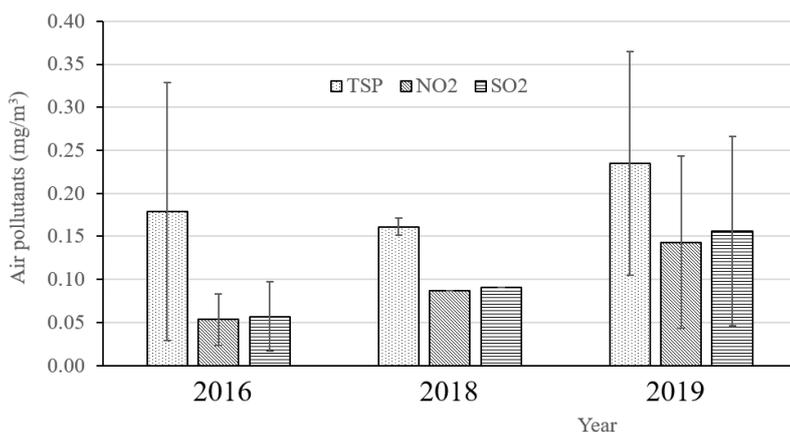


Figure 7. TSP, NO_2 , SO_2 in the air in urban area for the period of 2016-2019

O_3 in the air in urban areas ranged from 0.02 ± 0.03 - $0.01 \pm 0.02 \text{ mg/m}^3$, meeting QCVN 05: 2013/BTNMT (0.35 mg/m^3) [8] in 2016, 2019. O_3 is an important pollutant that causes murderous disasters caused by photochemical smoke [11]. Hydrocarbon gas was not detected in air monitoring 2016-2019.

3.3 Air quality in the transportation sites

The measured temperatures at the ferry terminals and bus stations varied from 32.23 ± 1.74 - $33.4 \pm 1.42^\circ\text{C}$ (Figure 8), with the average temperature being 32.82°C . At Pham Cu Luong Bus Station, the heat base in 2019 was lower than those of 2 years ago, in contrast at the Vam Cong ferry terminal, the heat base was higher than those in 2016-2016. The rapid rate of temperature change causes heat shock to the living organisms, heat pollution in the air environment creates conditions for bacteria to grow rapidly and cause disease [11]. Therefore, it is necessary to limit going out during high temperature periods, as well as reducing emissions, which contribute to increased temperature in the air.

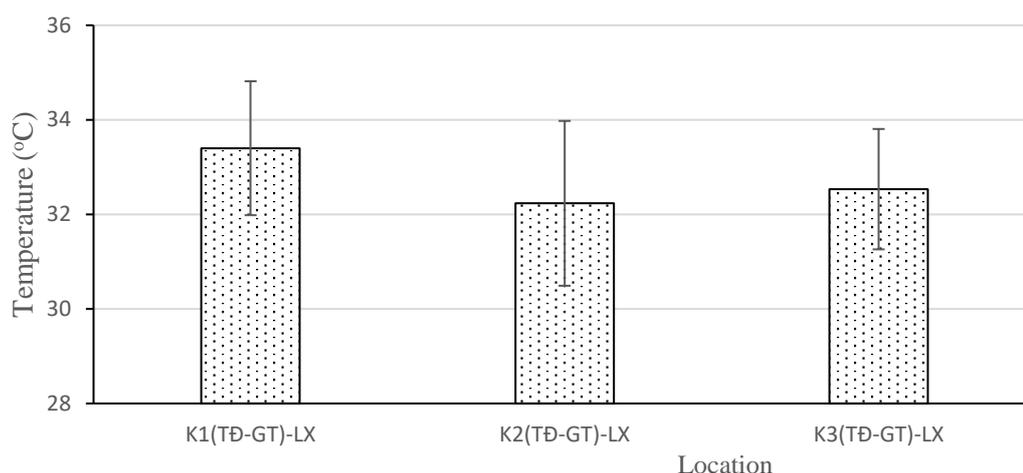


Figure 8. Temperature in air in the transport sites for the period 2016-2019

Because vehicles as well as passengers circulate frequently, with dense frequency, the noise at the monitoring locations was always high but still meets QCVN 26: 2010/BTNMT [7] standards except for 2016 (exceeding QCVN 26: 2010/BTNMT). Noise was of high values at the ferry and bus station locations as it was the main traffic route between Ho Chi Minh City with An Giang and neighboring provinces. According to some studies, the vehicle will generate the greatest noise when running at low gear, so reducing the number of stops and starts will reduce traffic noise, or build a protective wall and planting trees on both sides of the road to reduce noise [11]. The ANOVA statistical results showed that the noise between three observed locations over the years 2016-2019 has no significant difference at 5% (Figure 9).

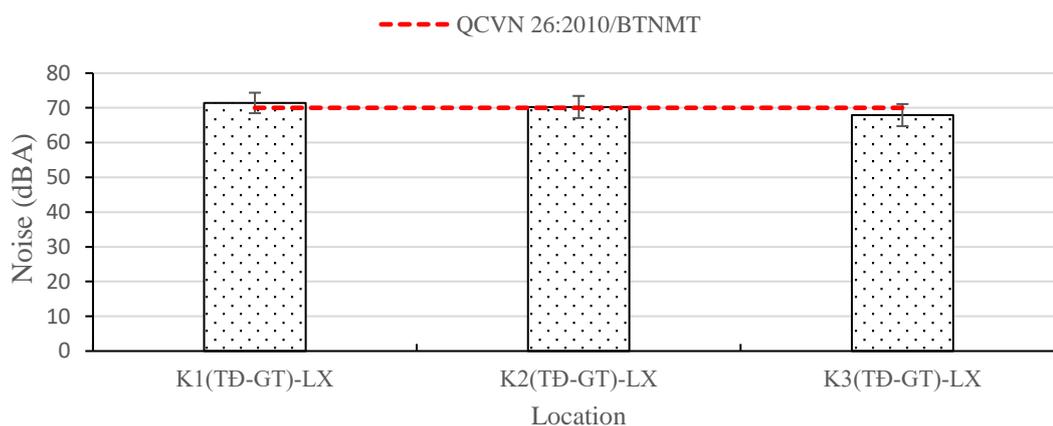


Figure 9. Noise in air in the transport sites for the period 2016-2019

The total suspended dust content ranged from 0.16 ± 0.07 - 0.35 ± 0.16 mg/m³ (Figure 10), except for the other two locations, at Vam Cong ferry -K2 (TĐ-GT)-LX, TSP content exceeded 1.1 times higher than the standard QCVN 05: 2013/BTNMT (0.3 mg/m³) [8] due to the number of cars waiting for ferries, ferries are in operation, the number of passengers and vehicles passing relatively large exhausted total suspended dust into the environment. The ANOVA analysis showed that the total concentration of suspended dust in the period 2016-2019 at the Vam Cong-ferry K2(TĐ-DT)-LX increased significantly and there was a difference with the other two locations ($p < 0.05$).

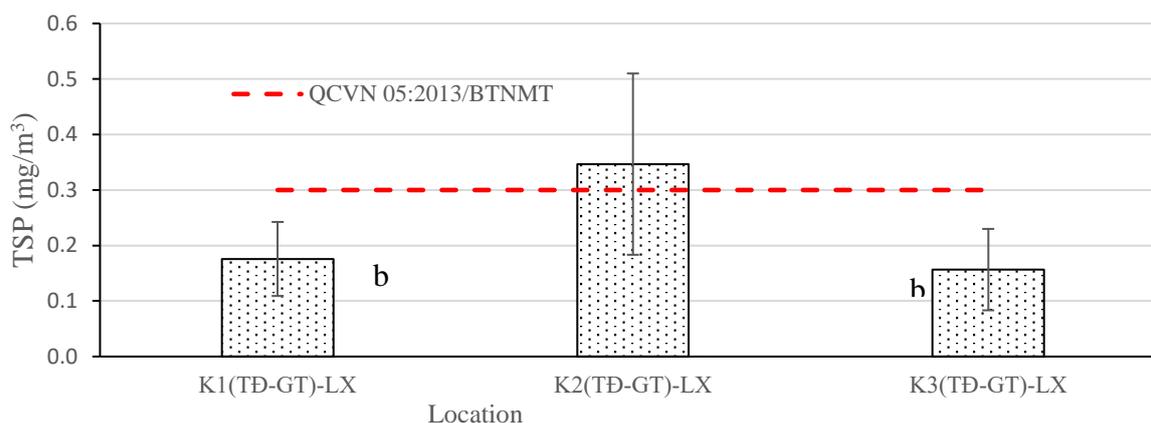


Figure 10. TSP in air in the transport sites for the period 2016-2019

Average CO concentration at the ferry terminal and bus terminal in the period 2016-2019 ranged from 6.03 ± 2.15 - 8.30 ± 2.95 mg/m³ (Figure 11), the highest CO was at the ferry terminal at Vam Cong-K2 (TĐ-GT)-LX and lowest at Pham Cu Luong-K3(TĐ-GT)-LX bus station. There was significant difference between the ferry terminal and the bus station. However, CO still reached the standard limit of QCVN 05: 2013/BTNMT (30 mg/m³) [8] and did not differ between years ($p > 0.05$).

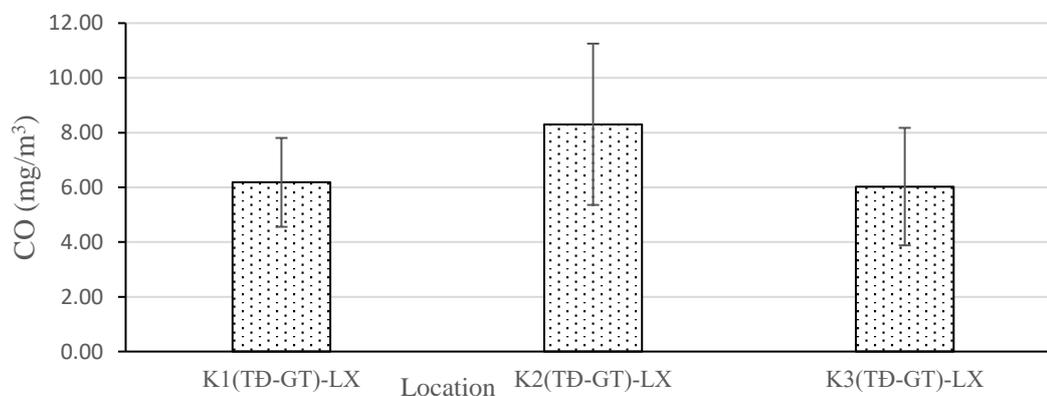


Figure 11. CO in air in the transport sites for the period 2016-2019

NO₂ in the period 2016-2019 ranged from 0.08 ± 0.03 - 0.11 ± 0.06 mg/m³ (Figure 12), the highest at Vam Cong ferry-K2(TD-GT)- LX. NO₂ at all locations was qualified according to QCVN 05: 2013/BTNMT (0.2 mg/m³) [8]. NO₂ is a gas capable of absorbing hemoglobin 300,000 times higher than O₂ so it can reduce the ability to carry oxygen in the blood, which can be fatal in high concentrations. Because of the harmful effects of NO₂, it is necessary to protect health against this pollutant, although the NO₂ concentration meets the standard, measures are needed to prevent and mitigate them in the future. In addition, the ANOVA analysis results showed that the NO₂ content did not differ between the observed locations over the years 2016-2019 ($p > 0.05$).

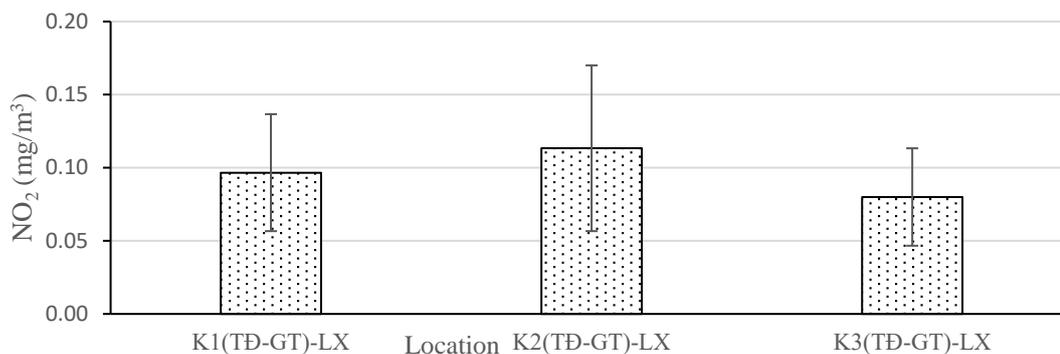


Figure 12. NO₂ in air in the transport sites for the period 2016-2019

At the ferry and bus stations, the measured SO₂ content ranged from 0.09 ± 0.04 - 0.1 ± 0.05 mg/m³ (Figure 13). In general, the SO₂ content at Vam Cong ferry-K2 (TĐ-GT)-LX was higher than that at the bus station-K3 (TĐ-GT)-LX, but SO₂ at all monitoring locations meet QCVN 05: 2013/BTNMT (0.35 mg/m³) [8]. However, it is necessary to be careful when the concentration of SO₂ in the air is high because they are present in our lives through activities such as burning fuels, coal, and oil. Former study showed that SO₂ causes strong stimulation, reduces vision, and contributes to cardiovascular diseases [12]. Analysis results showed that concentration of SO₂ did not differ between the monitoring locations in the period 2016-2019.

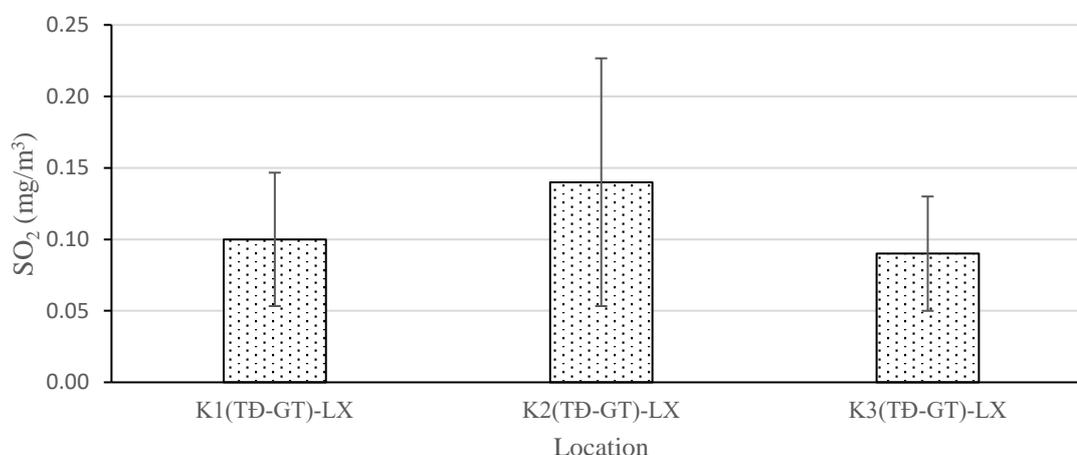


Figure 13. SO₂ in air in the transport sites for the period 2016-2019

O₃ in the air at traffic areas at the monitoring locations in the period 2016-2019 ranged from 0.02 ± 0.02 - 0.02 ± 0.03 mg/m³ (Figure 14), meeting QCVN standards 05: 2013/BTNMT (0.2 mg/m³) [8]. Regarding the harmful effects of O₃, when the concentration is at 0.3-1 ppm, exposure for 1.5-2 hours has symptoms of suffocation, tired cough occurs, if at concentration of 1.5-2 ppm, exposure for more than 2 hours chest pain, cough, headaches, unbalanced body, fatigue, and aches and pains in the bones and joints, at a concentration of 9 ppm, will cause serious illness [12]. It is necessary to limit the generation and increase of O₃ in the environment, to ensure the safety of the health of the people living in the monitoring areas to detect the existence of this gas.

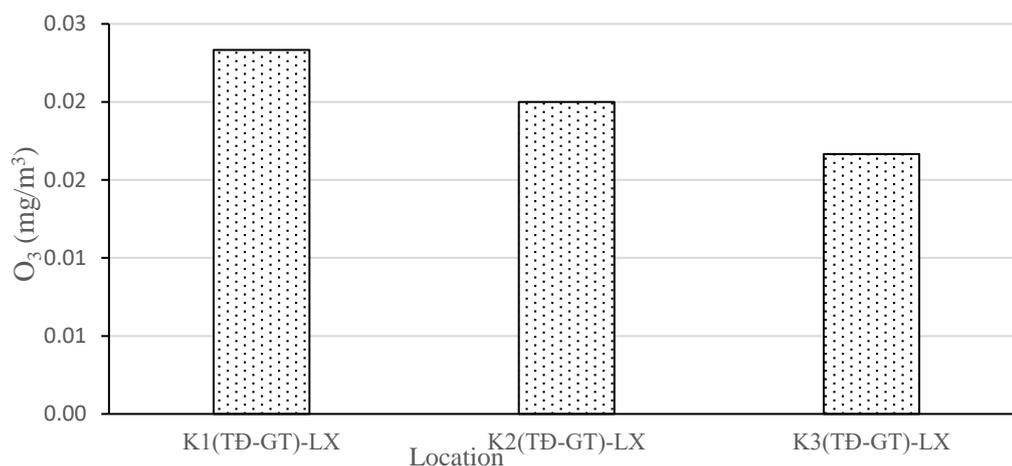


Figure 14. O₃ in air in the transport sites for the period 2016-2019

4. Conclusion

Air quality was affected by the industrial activity in 2016-2019 showing signs of mild pollution, although all parameters meet the allowable standards. Noise decreased over the years, however TSP, CO and SO₂ tended to increase mainly due to the high circulation of vehicles in the industrial park. NO₂ concentration increased gradually, was a warning sign of the deteriorating air quality and the potential to have a great impact on the health of workers inside and people near the industrial zone. The quality of the urban air environment showed signs of mild noise pollution, the rest of the parameters meet the permitted standards. Noise pollution over the years tended to increase slightly, not ensuring good for human health, affecting the quietness and rest of the people, especially for the elderly and young children. Air quality was affected by traffic in Long Xuyen city in general, ferries and bus stations in particular were polluted by noise, but still within acceptable limits, there were 2 out of 3 the monitoring positions all exceeded the QCVN 26: 2010/BTNMT standards. The results showed that the air environment has little problems with noise, NO₂, CO, SO₂, NO₂ and TSP. It is necessary to have control measures to limit impacts of future air pollution on public health, ecosystems and infrastructure.

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