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Long-term Measurements of Toluene and NO_2 at Selected Locations in Kuwait

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Abstract

Toluene and NO2 pollutants have an adverse effect on human health.

Objective: In this research, we measured the concentrations of both Toluene and NO2 during 2019 in selected areas in Kuwait and their sources, including the Shuwaikh industrial area which has a large number of car service shops which may be the source of high concentrations of toluene. Methods: Datawere obtained from the Envista software used by the Kuwait Environmental Public Authority (KEPA) which measures the pollutants every minute daily in different locations in Kuwait.

Results:Toluene results from the Shuwaikh industrial area showed the highest concentration reading (17.465 ppb) in November at 20:00. As for NO2, the highest concentration readings for the Shuwaikh industrial area, Al Salam, and Al-Mutla were (68 ppb) in May at 21:00 hours, (128 ppb) in February at 07:00 hours, and (83 ppb) in January at 21:00 hours and 22:00 hours respectively.

Conclusion:The higher concentrations for both toluene and NO2 in the Shuwaikh industrial area are correlated with higher levels of traffic. High concentrations of NO2 in Al-Salam and Al-Mutla are also related to traffic.

Keywords: Toluene • Nitrogen Dioxide (NO2) • VOCs

Introduction

Air pollution has an adverse effect on human health, having been associated with heart disease, stroke, cancer, and mortality in general [1-3]. Pollutants including Nitrogen Dioxide (NO_2), benzene, toluene, ethyl-benzene, and xylenes (BTEX), and particulate matters ($PM_{2.5}$) are generated via the incomplete combustion of fossil fuels from vehicles, households, and industrial activities [4-6]. Toluene and nitrogen dioxide (NO_2) have an adverse effect on human health. Constant exposure to high levels of toluene, which is one of the Volatile Organic Compounds (VOCs), can affect the human bone marrow, and cause DNA damage in mammalian cells and damage to the immune system. The effects of moderate exposure to toluene include irregular heartbeat, headaches, dizziness, nausea, and unconsciousness [7]. NO_2, on the other hand, has adverse effects on the respiratory system [8,9], and can cause molecular aging among healthy women [10] and cardiovascular risk at a personal exposure level [5,11,12]. This research presents long-term measurements for Toluene and NO_2, taken in 2019 in selected locations in Kuwait, including the Shuwaikh industrial area, Al Salam, and Al-Mutla, where toluene was measured at Shuwaikh Station (Industrial Area), and NO_2 measured at Shuwaikh (Industrial Area), Al Salam (Residential Area) and Al-Mutla Station [13].

Methods

The software used for statistical analysis was as follows: Envista ARM is a Windows client-server application for the supervisory control, management, and analysis of data from Environmental, Meteorological and Hydrological monitoring networks, used in the Kuwait Environmental Public Authority (KEPA).

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The following steps were followed to ensure data quality and integrity:

a) Invalidating all communication and operational failures

b) Ensuring that data capture was at least 75%

c) Reviewing zero and span calibration, one-point QC verification, station logs, and station maintenance sheets

Fortnightly calibration reports were used to calculate the true analyzer zero and response factor and to scale the data. Overall accuracy of ± 5% was applied to the data.

Results

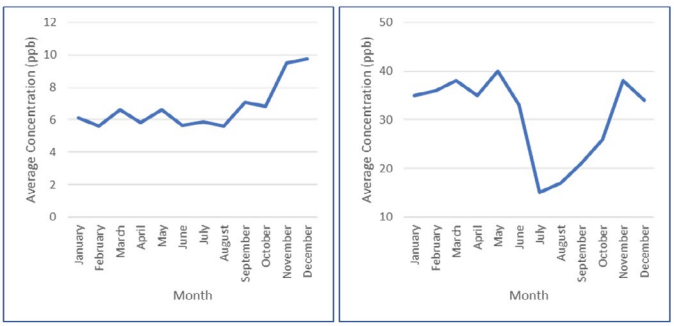

Figure 1. Monthly concentrations -Shuwaikh a) Toluene; b) NO_2.

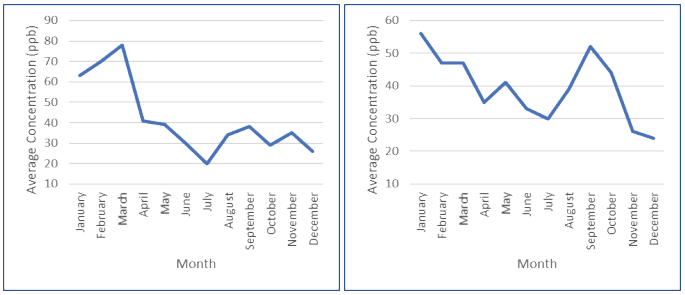

Figure 2. NO_2 monthly concentrations a) Al-Salam; **b)** Al-Mutla.

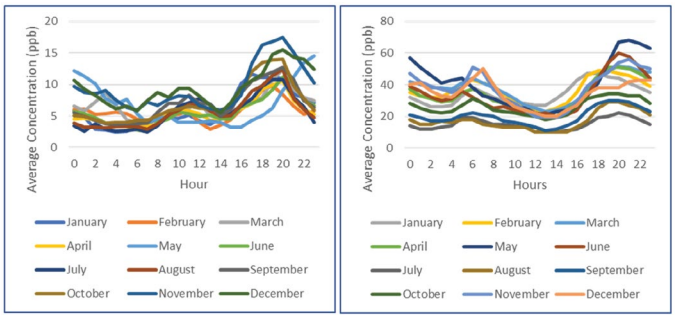

Figure 3. Hourly concentrations-Shuwaikh a) Toluene; **b)** NO_2.

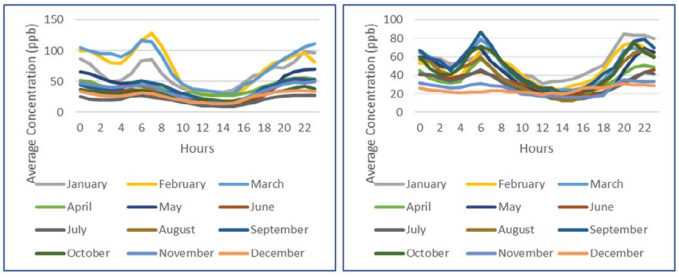

Figure 4. NO_2 hourly concentrations a) Al-Salam; **b)** Al-Mutla.

Table 1. Highest Concentrations of Toluene and NO_2 in selected areas of Kuwait, 2019.

Station	Time	Month	Concentration
Toluene-Shuwaikh	20:00	November	17.465
NO_2-Shuwaikh	21:00	May	68
NO_2-Al Salam	07:00	February	128
NO_2-Mutla	21:00 and 22:00	January	83

The Toluene results from the Shuwaikh industrial area showed the highest concentration reading (17.465 ppb) in November at 20:00 hours (Table 1). As for NO_2, the highest concentration readings for the Shuwaikh industrial area, Al Salam, and Al-Mutla were (68 ppb) in May at 21:00 hours, (128 ppb) in February at 07:00 hours, and (ppb) in January at 21:00 hours and 22:00 hours respectively. Figures 1 and 2 shows the monthly concentrations and Figures 3 and 4 shows the hourly concentrations for 2019.

Observations

- Higher concentrations of both toluene and NO_2 in the Shuwaikh industrial area are correlated to higher levels of traffic
- High NO_2 concentrations in Al-Salam and Al-Mutla are also related to traffic

Activities related to oil exploration in north Kuwait are contributing to increasing concentrations of NO_2 in the hours between 05:00 and 09:00 and 17:00-22:00 in Al-Mutla.

Discussion and Conclusion

Shuwaikh Station is situated in Block C of Shuwaikh Industrial Area 3. The station is located on top of Shuwaikh Industrial Health Centre, which is located within a conglomerate of various small-scale industries like motorcycle repair garages, water ski and boat shops, warehouses, and HVAC and radiator manufacturers and contractors. Toluene is extensively used in these industries as a common solvent, e.g. in paint, paint thinners, silicone sealants, many chemical reactants, printer ink, adhesives (glues), lacquers, and disinfectants, and the hourly trends show that the highest toluene readings are during the evening between 16:00 and 22:00. Another peak can be noted in the morning between 07:00 and 13:00. This variation is due to peaks in traffic movement.

As for NO_2 in Shuwaikh industrial area, the occurrence of higher values of air pollution in different months of a year is associated with the climate, and accordingly with different atmospheric conditions in particular months, the changing weather on a given day, and anthropogenic activity. The most prominent anthropogenic source of NO_2 is motor vehicle exhausts. The monthly trends shown above are, again, directly related to traffic volumes in Kuwait. The minimum levels were recorded in July and August, which are during the summer vacations when the traffic volume is at its lowest. The maximum levels.

were recorded in the months with the highest traffic volume in Kuwait. It must also be noted that the minimum levels were recorded in the summer season, which is also characterized by high winds causing severe dust storms that can disperse pollutant emissions. In winter, high ground-level concentrations of pollutants are caused by more stable meteorological conditions.

In Al-Salam, the occurrence of higher values of NO_2 in specific months is associated with the climate, and accordingly with different atmospheric conditions in particular months, the changing weather on a given day, and anthropogenic activity. The Al Salam station is situated on top of the Al Salam Health center. On the North and Northwest side of Al Salam Station is the Fifth Ring Road, and on the East and South Eastside is the Ahmadi Expressway. Both highways experience high volumes of traffic during peak travel periods. The hourly trends show that the highest NO_2 readings are in the morning between 05:00 and 09:00, corresponding to the peak traffic and clinic traffic period. Another peak is noticeable during the evening hours and continues until midnight. This variation is also due to traffic movement on the highways surrounding the station.

In Al-Mutla, the occurrence of higher values of air pollution in January could be due to high camping traffic which is a common occurrence during the winter season. Mutla station is situated on Highway No. 80 on top of the Land Border security office. The highway is frequented by Kuwait Oil Company (KOC)-North Kuwait and Abdali Farms traffic. The hourly trends show that the highest NO_2 readings are in the morning between 05:00 and 09:00 and the evening between 17:00 and 22:00, corresponding with the working hours of KOC North Kuwait. Over weekends, high traffic movement for Abdali Farms can be noted.

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