Ambient air quality monitoring in southern Kuwait

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Abstract

Ambient air quality monitoring was conducted at twenty locations in the southern part of Kuwait as part of an environmental impact assessment study requested by the Kuwait National Petroleum Company. Two waves of passive samplers (triplicates) were used to measure: NO, NO_2, SO_2, H_2S, NH_3 and a high volume sampler was used to measure PM10. During the sampling period, the wind was observed to be predominately from the west and northwest with an average speed of 4.28m/s. A comparison between the measured concentrations and the applicable air quality standards promulgated by the Kuwait Environment Public Authority showed that those compounds had very low concentrations compared to both industrial and residential KEPA standards and accordingly there is no violation of KEPA air quality standards.
Keywords: passive samplers, air pollution, PM10.

1 Introduction

The Kuwait National Petroleum Company (KNPC) requested that the Kuwait Institute for Scientific Research (KISR) conduct a baseline Environmental Impact Assessment (EIA) study for building the fourth refinery in Az-Zour area in the southern part of Kuwait, which is shown in Figure 1. In this paper we report on the results of the ambient air quality monitoring part of the conducted EIA.

2 Sampling locations

Ambient air quality monitoring was conducted at twenty locations as shown in Figure 1. The UTM coordinates and description are listed in table 1. The

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monitoring locations include the planned New Refinery site, the coastal area adjacent to the planned marine terminal site, nearby residential areas and locations upwind and downwind of the Az-Zour North and South Power Stations (bounded by A7, A8 and A9).

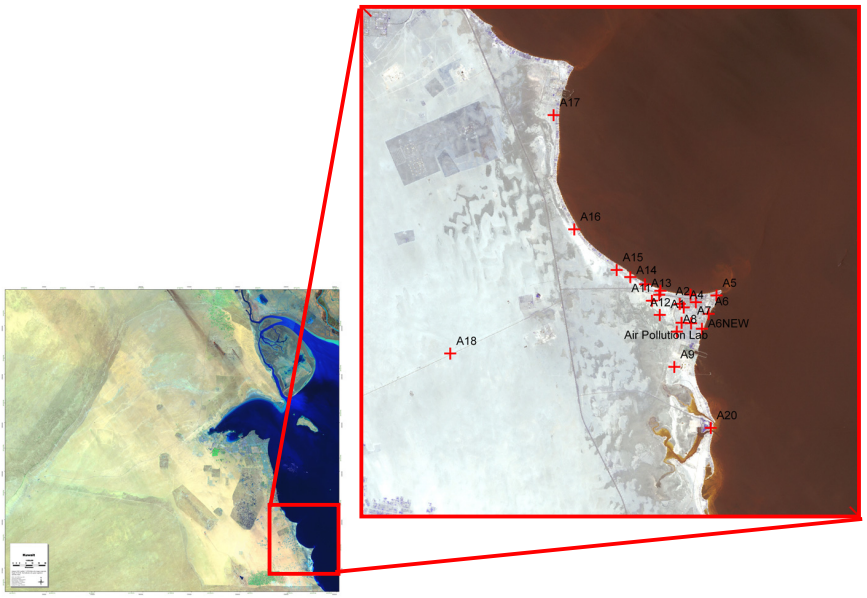

Figure 1: Locations of ambient air quality monitoring.

3 Monitoring techniques

Passive samplers (triplicates – refer to Figure 2) were used at twenty locations to measure the following components: NO, NO_2, SO_2, H_2S and NH_3. The samplers were secured to existing structures or on temporary supports. The samplers were deployed using a PVC rain shelter and incorporated support clips provided by the manufacturer (IVL Swedish Environmental Research Institute Ltd - Gothenburg, Sweden). Even in the absence of rain, the shelter is required to minimise dust contamination and the effects of advection on the diffusive samplers. Based on the passive samplers manufacturer's advice, the samplers were left in the field for 336 hours. Prepared samplers were transported to and from the field in air-tight containers, and minimally handled in the field using latex gloves. The passive samplers were then sent to IVL for analysis. Passive samplers were installed in two waves between 26/10/2005 and 24/11/2005.

During the sampling period, the meteorological conditions, e.g. wind speed and direction, relative humidity, precipitation, atmospheric pressure and temperature, were monitored using portable weather stations. The wind was observed to be predominately from the west and northwest with an average speed of 4.28m/s. From the windrose plot shown in Figure 3, it can be seen that

14% of the measured wind had an angle of 259° - 281°, 15% had an angle of 281° - 304°, 13% had an angle of 326° - 349° and 13% had an angle of 349° - 11°. Precipitation was recorded on 12th and 13th November 2005. The average atmospheric pressure and temperature 1014Pa and 22.4°C respectively and the average relative humidity was 56%.

Table 1: Locations of ambient air quality monitoring – based on 39 projection.

Location	X	Y	Description
A1	243627	3182158	Health Clinic Yard
A2	242897	3181526	Outside the fence of a school
A3	243991	3181641	The roof of the local police station
A4	243163	3181286	Open area close to village houses
A5NEW	241572	3182422	Near the beach
A6NEW	244402	3179826	Near the northeastern corner of Zour Power Station
A7	243665	3180202	Approximately 200m from Az-Zour North Power Station northern boundary
A8	242695	3179628	Approximately 200m from Az-Zour North Power Station western boundary
A9	242526	3177219	Approximately 200m from Az-Zour North Power Station southern boundary
A10	241494	3182145	New refinery boundary
A11	240993	3181745	New refinery boundary
A12	241528	3180770	New refinery boundary
A13	240524	3182861	Outside the first house in the beach village
A14	239521	3183360	1km from A13 outside the coastal houses
A15	238596	3183844	2km from A13 outside the coastal houses
A16	235706	3186621	4km from A15 outside the coastal houses
A17	234296	3194417	8km from A16 outside the coastal houses
A18	227250	3178135	18km from new refinery site, 200m away from roadside
A20	245001	3173056	Existing residence at Khiran Resort
APL	243015	3180239	Inside Az-Zour North Power Station fence

Figure 2: Triplicate set of the passive samplers.

A PM10 Volumetric Flow Controlled (VFC) high volume air sampler (VFC System – Model TE-6070V, Tisch Environmental Inc. – Ohio, USA, shown in Figure 4) was used to measure the PM10 levels at four locations (A3, A13, A17 and A20). The high volume air sampler uses Micro-Quartz filter (Model: Whatman-PN 1851-865 QM-A (8 x 10 inch)) with 99.95% particle retention (0.3μm) which is recommended for use in USEPA PM10 ambient air monitoring. The high volume air sampler was calibrated using a TE-5028 variable orifice calibrator for a pressure difference range of 12-19inch H_2O. At each monitoring location, the high volume air sampler was left on for nearly 24 hours and the total volume of air (actual and standard) passed through the filter was calculated to estimate the PM10 concentration.

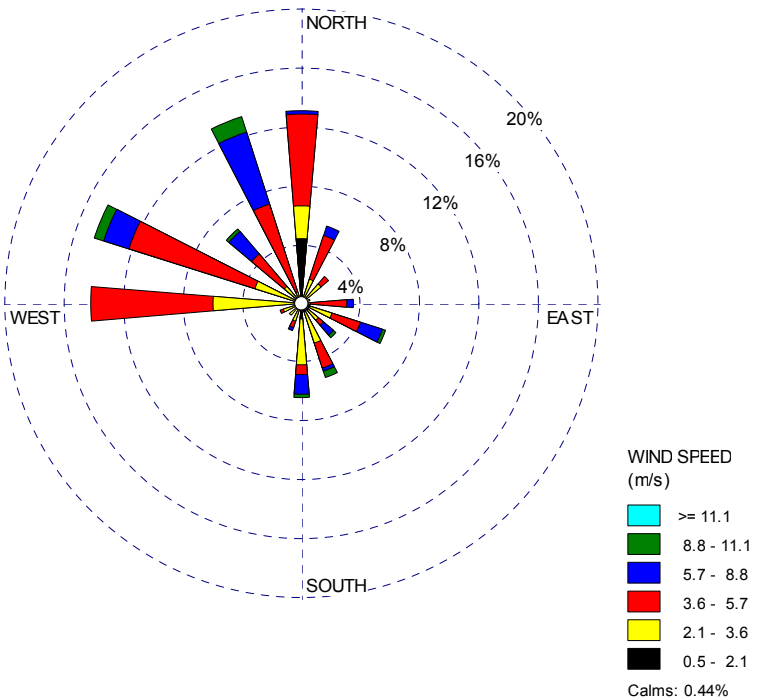

Figure 3: The windrose plot for the sampling duration.

Figure 4: The PM10 high volume air sampler in use at A17.

4 Results and discussion

- The contour plots for the concentrations obtained for NH_3, NO_2, NO, SO_2 and H_2S are shown in Figures. 5-9. The PM10 concentrations are shown in Figure 10. Table 2 lists the maximum, minimum and average concentrations detected by the passive samplers.

Table 2: The average, maximum and minimum concentrations measured and their locations.

Pollutant	Concentration (µg/m3)				
	Max	Location	Min	Location	Average
NH3	4.43	A9	2.53	A1 & A20	3.35
NO2	18.63	APL	7.43	A18	14.9
NO	14.1	A20	7.87	A18	11.48
SO2	16.4	A3 & A7	10.47	A17	13.24
H2S	7.8	A18	2.4	A10	4.53
PM10	90.47	A17	40.43	A3	67.93

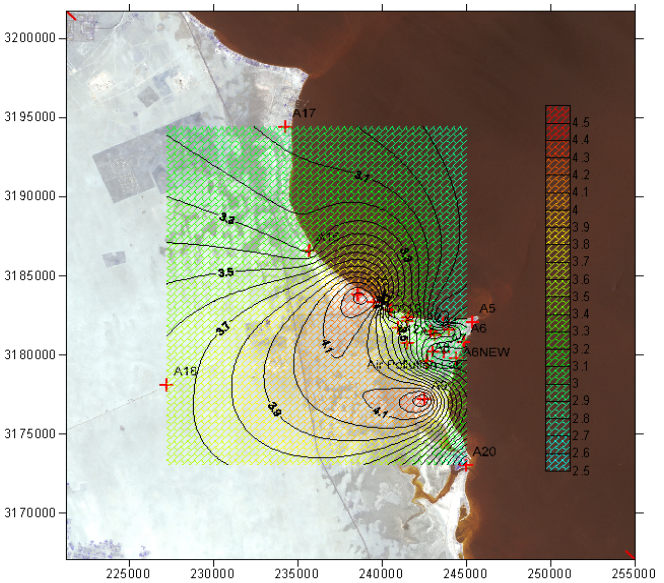

Figure 5: Showing the contour plot for the NH_3 concentrations.

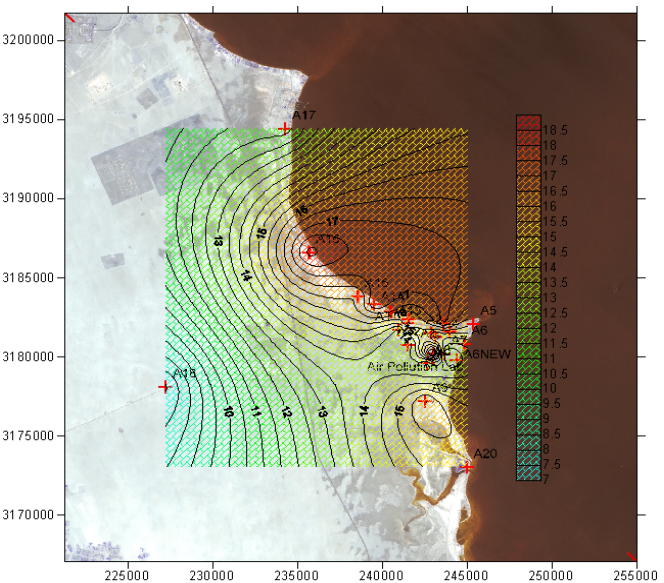

Figure 6: Showing the contour plot for the NO_2 concentrations.

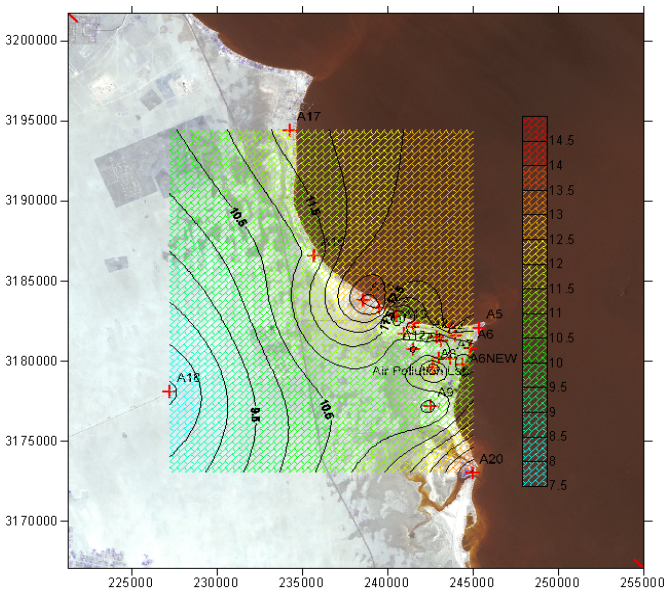

Figure 7: Showing the contour plot for the NO concentrations.

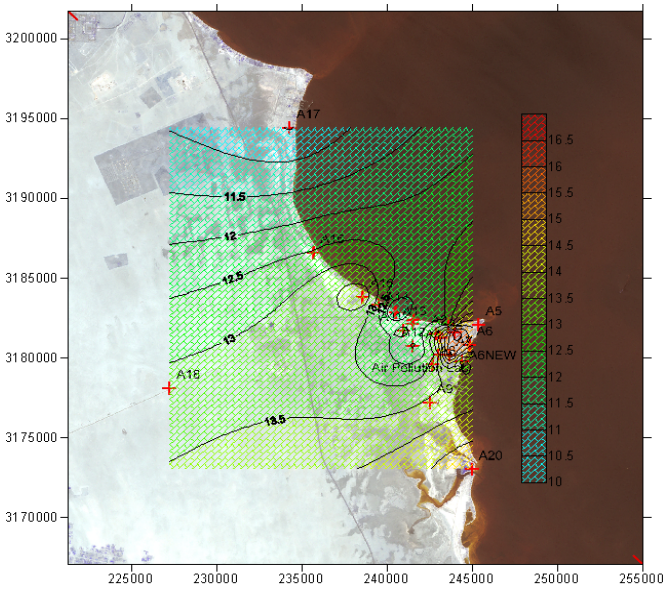

Figure 8: Showing the contour plot for the SO_2 concentrations.

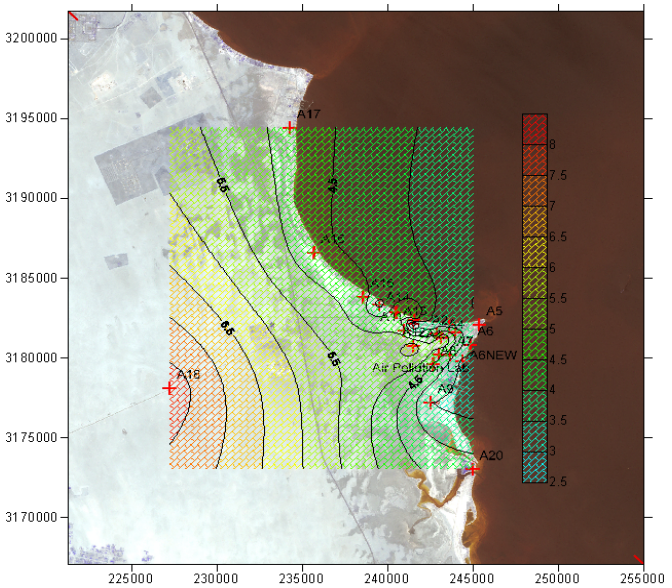

Figure 9: Showing the contour plot for the H_2S concentrations.

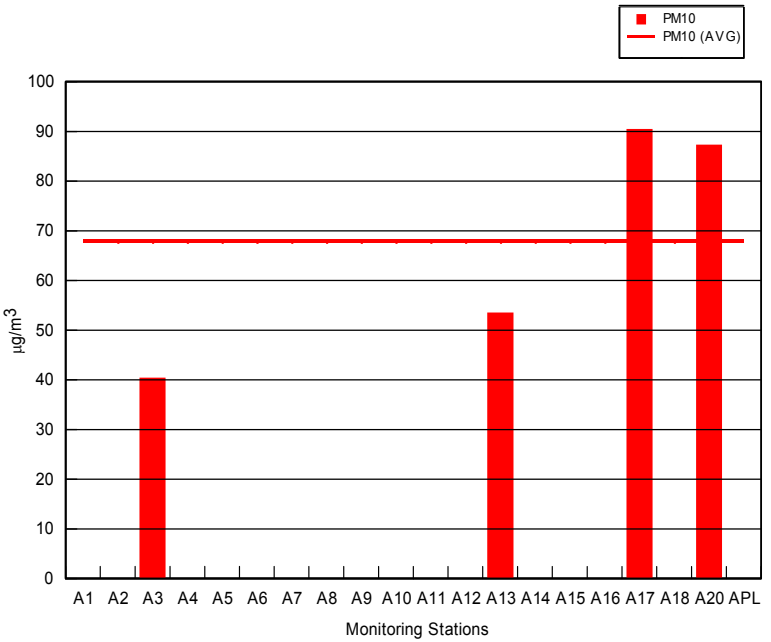

Figure 10: Distribution of the PM10 concentrations.

NH_3 concentration is highest at A9 and A15. A9 was near a landfill site while A15 was inside a farmhouse with poultry. Agricultural activities, in particular animal husbandry, are the dominant source of NH_3 emissions to the atmosphere, contributing an estimated 90% of the total in Western Europe (Sutton *et al* [1] and Kirchmann *et al* [2]) and the US (Battye *et al* [3]). The NH_3 concentration drops rather quickly as we move away from the A15 and A13.

NO_2 distribution is high in the north-eastern part of the area where the car traffic is higher and it decreases gradually with distance towards the south-eastern region. Low NO_2 levels at A17 and A18 are indicative of the rural setting of the south-eastern part of the area. The NO distribution is similar to that of NO_2 with the minimum concentration attained at A18, which is on the side of a rarely used road. The maximum NO concentration was measured at A20 near a car park inside a heavily populated resort.

The high SO_2 concentration at A3 and A7 is due to oil handling and transport facilities (pipelines, pumps, etc) associated with Texaco activities. The high SO_2 concentration at A20 is contributed to the plume of Az-Zour Power Stations, which is deflected under the prevailing northwesterly winds.

The H_2S concentration was highest at A18, which was 10m from a crude oil pipeline. The PM10 measurements were not made at the same time; hence the concentration levels cannot be related to the locations. However, the high PM10 concentration at A17 can be related to the off-road driving activities on the measurements day.

A comparison between the measured concentrations and the applicable air quality standards promulgated by KEPA shows the following:

1. The maximum measured concentration ($4.43\mu g/m^3$) of NH_3 is negligible compared to all the KEPA residential and industrial standards for NH_3.
2. The maximum measured concentration ($18.63\mu g/m^3$) of NO_2 is less than one third of the KEPA yearly standards for both residential and industrial areas for NO_2.
3. The maximum measured concentration ($16.40\mu g/m^3$) of SO_2 is about one tenth of the yearly KEPA industrial standard and one fifth of the yearly KEPA residential standard for SO_2.
4. The maximum measured concentration ($7.80\mu g/m^3$) of H_2S is less than the yearly KEPA standard for residential areas for H_2S.
5. The maximum measured PM10 concentration ($90.47\mu g/m^3$) is less than one third of the daily KEPA standards for both residential and industrial areas for PM10.

5 Conclusion

The investigation, using multipoint passive samplers, has revealed a good degree of uniformity of pollutants distribution across the region of study.

The air quality monitoring task has been completed. Field measurements relied on passive samplers and continuous monitoring equipment. For the measured compounds, it was found that they had very low concentrations compared to both industrial and residential KEPA standards, and accordingly

there is no violation of KEPA air quality standards. The measured pollutant concentrations reflect the meteorological conditions at the time of sampling. The only location (A20) downwind of the Az-Zour power plant did not show high concentrations of SO_2. It is expected that concentrations for some of the criteria air pollutants sampled, particularly for SO_2, could have been significantly higher had the meteorological conditions placed the passive samplers directly downwind of the Az-Zour power plant's flue gas.

References

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