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Original Research Article

Study the Air Pollution in West Qurna-2 Oil Field Southern Iraq

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ABSTRACT

Gaseous pollutants such as HCs, NOx, SOx, O_3, and CO_2 are measured using the portable detection instrument (Drager Chip-Measurement System), whereas portable instrument of RK1 Gas Monitoring Eagle II, used for detected the pollutants of CH_4, H_2S, and CO. The results of the regional mean concentrations of the gasses at present study show that: The highest concentration of the gases (CO, CO_2, NOx, SOx, H_2S, CH_4 and HCs) is at station 10 (27.517, 312.475, 2.655, 3.15, 3.367, 14.597 and 14.060 ppm) and the lower is at station 1 (18.755, 270.4, 1.042, 2.227, 2.36 , 11.765 and 11.240ppm), while The highest mean concentration of O_3 gas is at stations5, 9 (0.1ppb) and the lower is in station 1 (0.08ppb). The result of the seasonal gasses show that the highest mean of the gasses (CO, CO_2, NOx, SOx, H_2S, CH_4, HCs and O_3) concentrations are recorded during winter (23.946, 307.58, 1.898, 2.921 , 3.131, 13.731, 13.508 ppm and0.104ppb respectively) while the lower are during summer (22.389, 289.09, 1.49, 2.432, 2.457, 12.468, 12.076 ppm and 0.084ppb). With respect to spatial variably of studied parameters, the parameters concentrations in studied stations gradually increase from station 1 to station 5, and then significantly decrease at station 6 and finally increased to station 10. The fluctuation in concentrations of concentrations in stations is due to distance from the flame of the flare which is near to the stations 8,9,10 and far to the stations 1,2,3,4,5,6,7, while the seasonal concentration arranges as following: winter >spring >autumn>summer.

Keyword: Air; gasses; pollution; West Qurna-2 oil field; southern Iraq

INTRODUCTION

Air pollution is one of the most important issues around the world and becoming the fundamental pollution problem in many parts of the world, especially in Iraq. Air contamination is a developing risk to human health and well-being as well as natural environment. It can be triggered via factories' activities, power plants, motor vehicles, wildfires and windblown dust [1].

A pollutant classified to natural and anthropogenic Sources, Natural pollutants are those which are emitted from natural sources, anthropogenic pollutants produced by human activity [2]. Both of them classified to primary or secondary pollutants. Primary pollutants are those which are emitted directly into the atmosphere from a recognizable source such as a factory smokestack. Secondary pollutants are those which are produced in the atmosphere by chemical and physical processes from primary pollutants and natural constituents [3]. As a result of complex chemical reactions which includes the primary pollutants and sunlight , the elements emitted from sources that then form new substances in the atmosphere such as non-methane VOCs conversion to ozone (O_3) [4 and 5]. Air contamination can be brought by natural or man-made activities and one of such activities is vehicular emission, which gets their energy from the combustion of fossil fuels. During the time spent burning, vehicles discharge into the environment exhaust gases, which create serious environmental and health concerns [6].

Carbon monoxide (CO), oxides of Sulphur (SOx), oxides of Nitrogen (NOx), Ozone (O_3), hydrocarbons and particulate matter are the emissions called Green House Gases (GHGs) [6]. 2% of the Earth's surface covering by Urban and suburban despite areas, are responsible for a huge fraction of greenhouse gas outflows to the air, representing 30% - 40% of worldwide anthropogenic emissions. This has resulted in an increasing number of measurements of atmospheric CO_2 mixing ratios in urban communities, as a mean of studying local GHG emissions, urban carbon cycles, and the spatial distribution in large urban regions, urban air pollution is developing as a key risk to health, the environment, and the quality of life of a great many peoples as the levels of urbanization, motorization, and economic activity increase (Greenhouse gases such as carbon dioxide, methane, and nitrous oxide is gases that stay all around for quite a while and warm up the planet by blockade sunlight because the gases act like the glass in a greenhouse it called the "greenhouse effect") [7].

Most of countries that produce a high percent of greenhouse gases are industrial countries [8]. Most of energy producing countries that produce greenhouse gases are the "developing countries" especially the oil and gas producing countries, which demands a Financial compensation for turning down production or for using alternative energy sources [9 and 10]. Countries destroys forests, especially the tropical forests [11]. Value Countries: which are the countries that do not produce greenhouse gases or destroy the environment, and they are classified into two types [12]: the first one is Countries that are affected by dryness and floods [13] while the second are Countries that collect air pollutants from neighboring countries and the number of their victims can be estimated to be 3 million people annually.

In Basra City, Southern Iraq the anthropogenic sources are the most important source for gaseous emissions [14]. This study aims to directly determine the concentrations of air pollutants emitted from both stationary and mobile outdoor sources in West Qurna -2 Southern Iraq Which is one of the most important oil field in the world.

MATERIAL AND METHODS

Gaseous emissions monitor seasonally during the period from September 2015 to March 2016 at ten stations in West Qurna-2 oil field at Basrah city, (Fig.1).

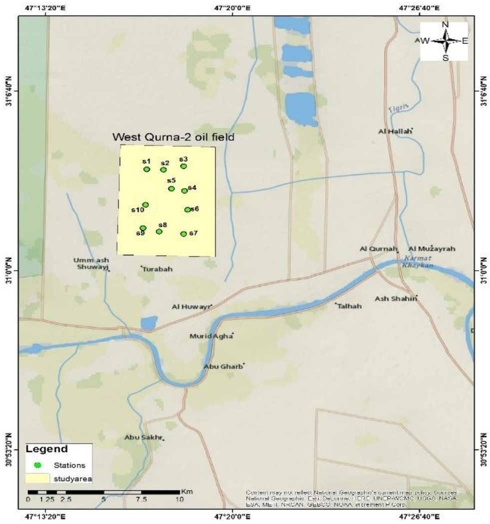


Fig. (1) The study area.

The chosen stations are kept to monitor the ambient air quality and gaseous emissions released from the nearby industrial plants. Carbon monoxide (CO), carbon dioxide (CO2), sulfate oxides (SOx), nitrogen oxides (NOx), ozone (O3), petroleum hydrocarbons (HCs), methane (CH4) and hydrogen sulfide (H2S) are the gasses which measured in this work. HCs, NOx, SOx, O3, and CO2 concentrations are measured utilizing the portable detection instrument of Drager Chip-Measurement System, Germany, whereas CH_4, H_2S, and CO detected by the portable instrument of RK1 Gas Monitoring Eagle II, USA.

RESULTS AND DISCUSSION

The results of the gasses concentrations at present study show that: The highest concentration of the gases (CO, CO_2, NOx, SOx, H_2S, CH_4 and HCs) is in Winter at station 10 (28.03, 322.3, 2.98, 3.44, 3.87, 15.08 and 14.66 ppm) while the lower in Summer at station 1 (18.20, 266.6, 1.00, 2.10, 2.21, 11.25 and 10.12ppm) (Tables 1,2,3,4,5,6 and 7) and (Fig. 2,3,4,5,6 and 7).while The highest concentration of O_3 gas is in Winter at stations 4, 5,7,8,9 (0.11ppb) and the lower at Summer in station 1 (0.07ppb) (Table 8 and Fig. 9).

Table 1: Seasonal variations of CO (ppm) gas with mean in West Qurna2 oil field

Station	Summer	Autumn	Winter	Spring	R. Mean	±SD
1	18.20	18.79	19.20	18.83	18.755	0.413
2	19.22	20.10	21.20	20.10	20.155	0.810
3	20.53	21.11	22.12	21.10	21.215	0.661
4	21.58	22.03	23.05	22.10	22.190	0.617
5	24.35	25.01	25.03	24.10	24.622	0.470
6	22.12	22.89	23.62	22.65	22.820	0.622
7	22.26	23.16	23.89	24.31	23.405	0.899
8	22.38	23.22	26.12	25.62	24.335	1.816
9	26.25	26.98	27.20	26.10	26.632	0.539
10	27.00	27.88	28.03	27.16	27.517	0.513
S. Mean	22.389	23.117	23.946	23.207	-	-

R.Mean= regional mean, S. Mean= seasonal mean.

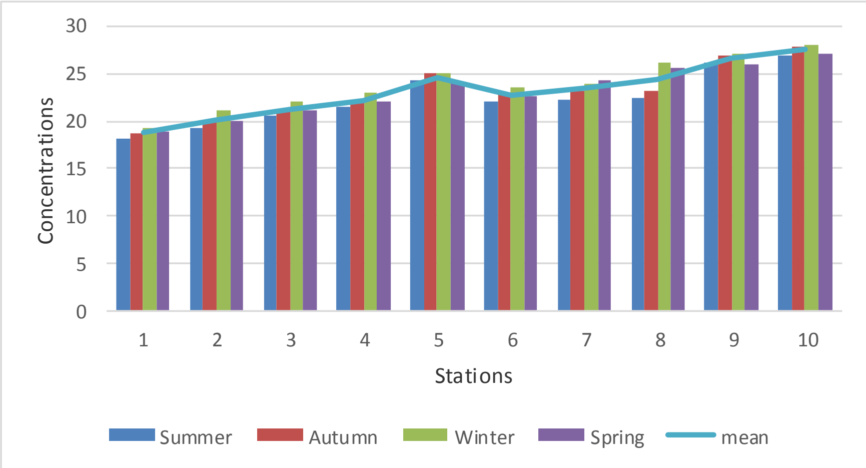


Fig 2: Seasonal and Mean concentrations of CO (ppm) gas at West Qurna2 oil field

Table 2: Seasonal variations of CO_2 (ppm) gas with mean in West Qurna2 oil field

Station	Summer	Autumn	Winter	Spring	R. Mean	±SD
1	266.6	268.8	275.9	270.3	270.4	3.969
2	280.5	283.5	289.7	285.3	284.75	3.848
3	280.5	288.9	297.8	293.2	290.10	7.359
4	286.1	290.7	305.8	301.4	296.00	9.152
5	298.3	300.6	315.5	311.6	306.50	8.347
6	288.5	293.8	311.4	306.3	300.00	10.651
7	296.0	301.8	317.9	309.5	306.30	9.506
8	296.3	303.9	319.2	310.6	307.50	9.745
9	298.0	306.1	320.3	318.2	310.65	10.501
10	300.1	306.9	322.3	320.6	312.475	10.751
S. Mean	289.09	294.5	307.58	302.7	-	-

R. Mean= regional mean, S. Mean= seasonal mean.

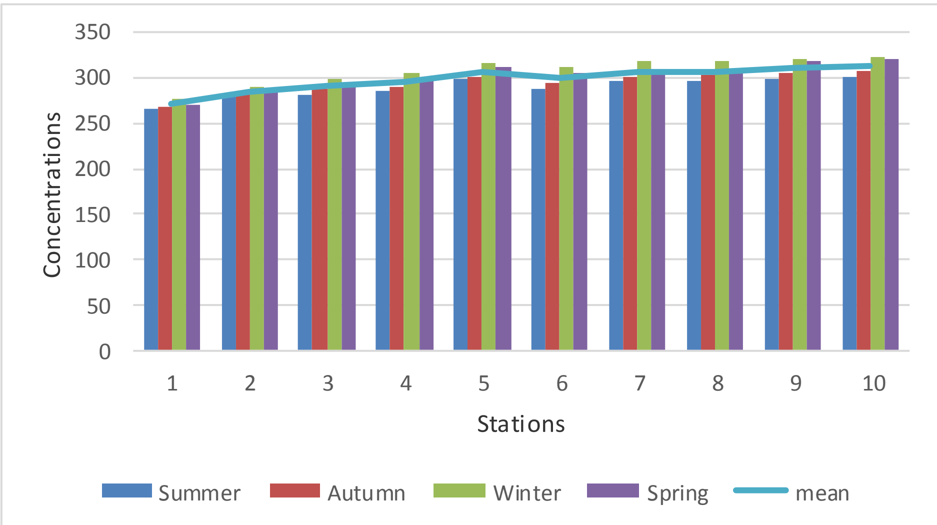


Fig 3: Seasonal and Mean concentrations of CO_2 (ppm) gas at West Qurna2 oil field

Table 3: Seasonal variations of NOx (ppm) gas with mean in West Qurna2 oil field.

Station	Summer	Autumn	Winter	Spring	R. Mean	±SD
1	1.00	1.03	1.09	1.05	1.042	0.037
2	1.02	1.06	1.10	1.08	1.065	0.034
3	1.03	1.08	1.18	1.14	1.107	0.066
4	1.10	1.21	1.42	1.32	1.262	0.138
5	1.92	2.10	2.54	2.34	2.225	0.271
6	1.12	1.30	1.52	1.34	1.320	0.164
7	1.22	1.38	1.65	1.58	1.457	0.195
8	1.95	2.23	2.63	2.42	2.307	0.288
9	2.03	2.26	2.87	2.63	2.447	0.374
10	2.51	2.29	2.98	2.84	2.655	0.313
S. Mean	1.49	1.594	1.898	1.774	-	-

R. Mean= regional mean, S. Mean= seasonal mean.

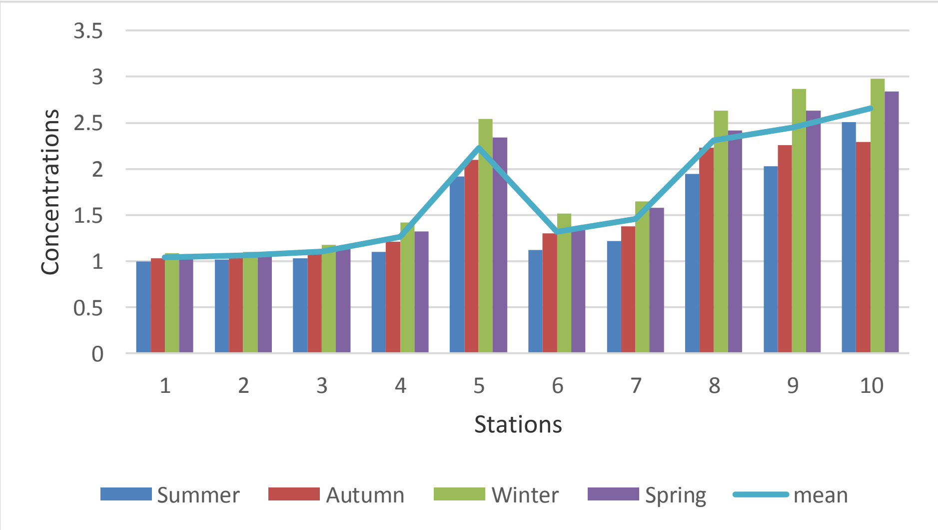


Fig 4: Seasonal and Mean concentrations of NOx (ppm) gas at West Qurna2 oil field

Table 4: Seasonal variations of SOx(ppm) gas with mean in West Qurna2 oil field

Station	Summer	Autumn	Winter	Spring	R. Mean	±SD
1	2.10	2.21	2.32	2.28	2.227	0.096
2	2.10	2.28	2.43	2.50	2.327	0.177
3	2.10	2.29	2.68	2.56	2.407	0.261
4	2.35	2.45	2.87	2.73	2.60	0.241
5	2.58	2.88	3.03	2.9	2.847	0.190
6	2.38	2.57	2.98	2.74	2.667	0.255
7	2.40	2.66	3.09	2.93	2.77	0.303
8	2.69	2.98	3.11	3.10	2.97	0.195
9	2.74	3.00	3.26	3.18	3.045	0.230
10	2.88	3.04	3.44	3.24	3.15	0.243
S. Mean	2.432	2.636	2.921	2.816	-	-

R. Mean= regional mean, S. Mean= seasonal mean.

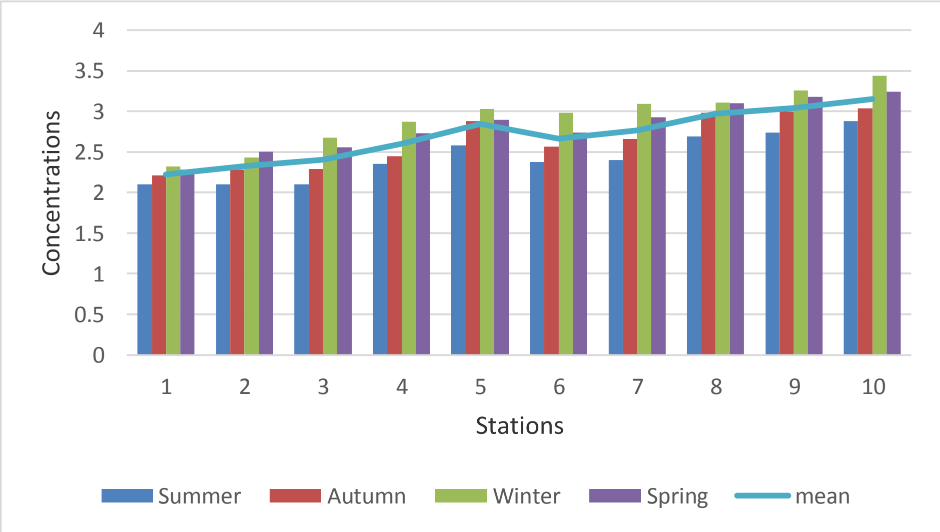


Fig 5: Seasonal and Mean concentrations of SOx (ppm) at West Qurna2 oil field

Table 5: Seasonal variations of H_2S (ppm) gas with mean in West Qurna2 oil field

Station	Summer	Autumn	Winter	Spring	R. Mean	±SD
1	2.21	2.26	2.65	2.32	2.36	0.198
2	2.22	2.29	2.78	2.54	2.457	0.255
3	2.25	2.31	2.89	2.47	2.48	0.288
4	2.38	2.41	2.99	2.86	2.66	0.310
5	2.63	2.89	3.08	2.98	2.895	0.192
6	2.40	2.52	3.02	3.00	2.735	0.321
7	2.40	2.63	3.15	3.08	2.815	0.360
8	2.50	2.85	3.23	3.12	2.925	0.325
9	2.65	2.95	3.65	3.46	3.177	0.459
10	2.93	3.02	3.87	3.65	3.367	0.463
S. Mean	2.457	2.613	3.131	2.948	-	-

R. Mean= regional mean, S. Mean= seasonal mean.

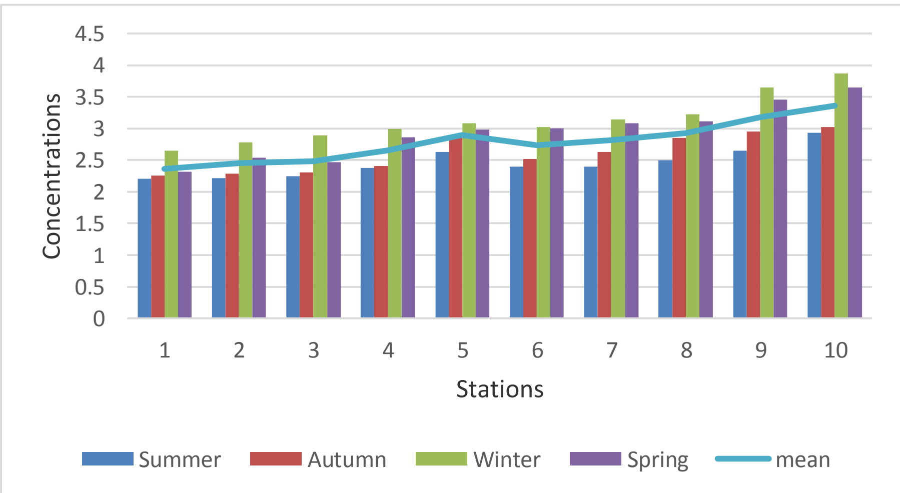


Fig 6: Seasonal and Mean concentrations of H_2S (ppm) gas at West Qurna2 oil field

Table 6: Seasonal variations of CH_4 (ppm) gas with mean in West Qurna2 oil field

Station	Summer	Autumn	Winter	Spring	R. Mean	±SD
1	11.25	11.87	12.05	11.89	11.765	0.352
2	12.02	12.46	12.87	12.65	12.500	0.361
3	12.06	12.72	13.07	12.87	12.680	0.437
4	12.10	12.89	13.12	13.00	12.777	0.461
5	13.22	13.78	14.09	13.98	13.767	0.386
6	12.11	13.32	13.69	13.42	13.135	0.700
7	12.14	13.42	14.23	14.21	13.500	0.982
8	12.16	13.65	14.45	14.36	13.655	1.058
9	13.50	13.89	14.66	14.50	14.137	0.539
10	14.12	14.32	15.08	14.87	14.597	0.451
S. Mean	12.468	13.232	13.731	13.575	-	-

R. Mean= regional mean, S. Mean= seasonal mean.

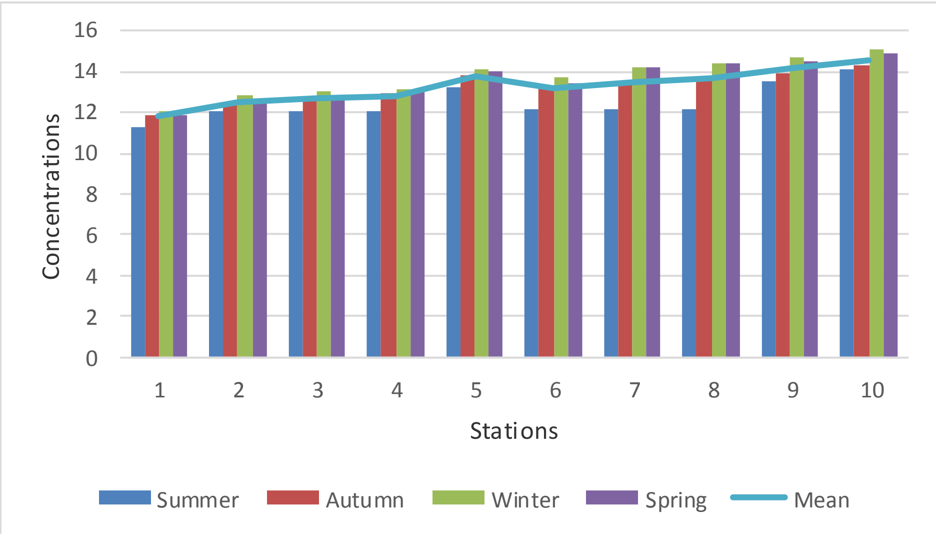


Fig 7: Seasonal and Mean concentrations of CH_4 (ppm) gas at West Qurna2 oil field

Table 7: Seasonal variations of HCs (ppm) gas with mean in West Qurna2 oil field

Station	Summer	Autumn	Winter	Spring	R. Mean	±SD
1	10.12	11.22	12.34	11.28	11.240	0.906
2	11.90	12.02	12.66	12.39	12.242	0.347
3	11.96	12.32	12.86	12.54	12.420	0.378
4	12.03	12.56	13.02	12.86	12.617	0.435
5	12.23	12.87	13.98	13.26	13.085	0.732
6	12.06	12.69	13.37	13.20	12.830	0.589
7	12.10	12.99	13.89	13.78	13.190	0.829
8	12.11	13.32	14.05	13.98	13.365	0.898
9	13.10	13.64	14.25	14.10	13.772	0.518
10	13.15	13.89	14.66	14.54	14.060	0.694
S. Mean	12.076	12.752	13.508	13.193	-	-

R. Mean= regional mean, S. Mean= seasonal mean.

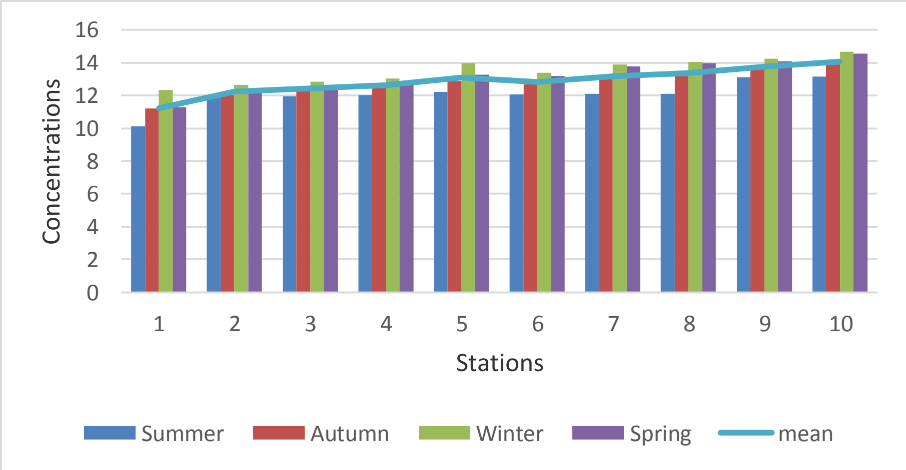


Fig 8: Seasonal and Mean concentrations of HCs (ppm) gas at West Qurna2 oil field

Table 8: Seasonal variations of O_3 (ppb) gas with mean in West Qurna2 oil field

Station	Summer	Autumn	Winter	Spring	R. Mean	±SD
1	0.07	0.08	0.09	0.08	0.08	0.008
2	0.08	0.09	0.1	0.09	0.09	0.008
3	0.08	0.09	0.1	0.09	0.09	0.008
4	0.08	0.09	0.11	0.10	0.095	0.012
5	0.09	0.10	0.11	0.10	0.10	0.008
6	0.08	0.09	0.10	0.09	0.09	0.008
7	0.09	0.09	0.11	0.10	0.0975	0.009
8	0.09	0.09	0.11	0.10	0.0975	0.009
9	0.09	0.10	0.110	0.10	0.10	0.008
10	0.09	0.10	0.10	0.10	0.0975	0.005
S. Mean	0.084	0.092	0.104	0.095	-	-

R. Mean= regional mean, S. Mean= seasonal mean.

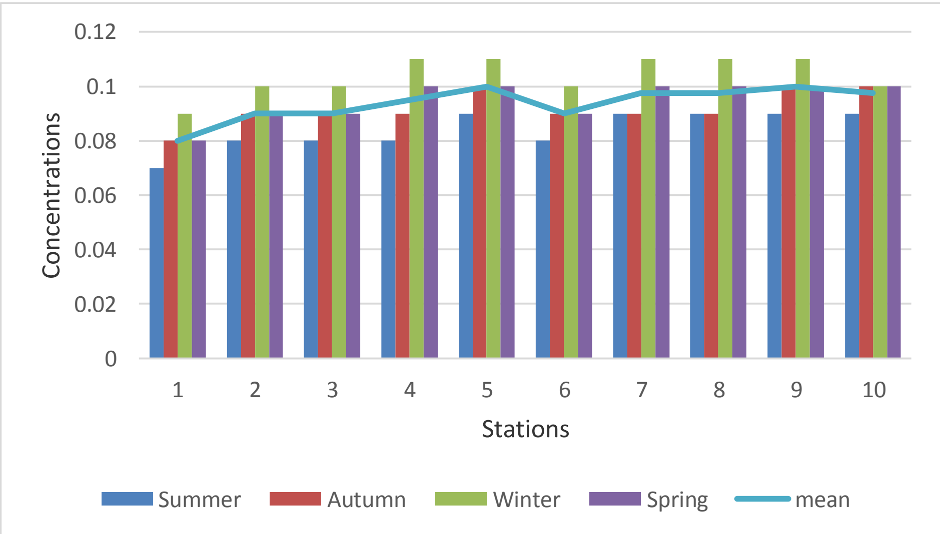


Fig 9: Seasonal and Mean concentrations of O_3 (ppb) gas at West Qurna2 oil field

The largest proportion of carbon monoxide emissions is produced as exhausts of internal combustion engines, especially by motor vehicles with petrol engines. Carbon dioxide exists in the Earth's atmosphere as a trace gas at a concentration of about 0.04 percent (400 ppm) by volume. It is present in deposits of petroleum oil and natural gas [5]. NO_2 which produced under high temperature combustion are major criteria pollutants that are precursors to photo- chemical smog, ozone, and acid formation. Sulfur dioxide mostly comes from the burning of oil [15]. CH_4 is concentred in places with the petroleum industry and exploitation within the study area [2]. O_3 concentrations increase in winter this may be a result of the photochemical reactions of nitrogen oxides.

Generally, the concentrations of CO, NO_2, SO_2, and HCs are recorded by the previous studies for the last ten years in the region are high [16] analyze the concentration of some air pollution in Basrah city, they found that concentration of CO is 300 ppm. [17] reports that CO concentrations range from 10 mg/L to 80 mg/L, while [14] states that the average concentration is 27 mg/L. [18] indicated that SO_2 concentrations range from 10 mg/L to 15 mg/L. In [14] the average concentrations of CO_2 and NO_2 are 300 mg/L and 3 mg/L respectively. In addition, [18 and 14] report that the average HCs concentrations are 5 mg/L and 2 mg/L, respectively.

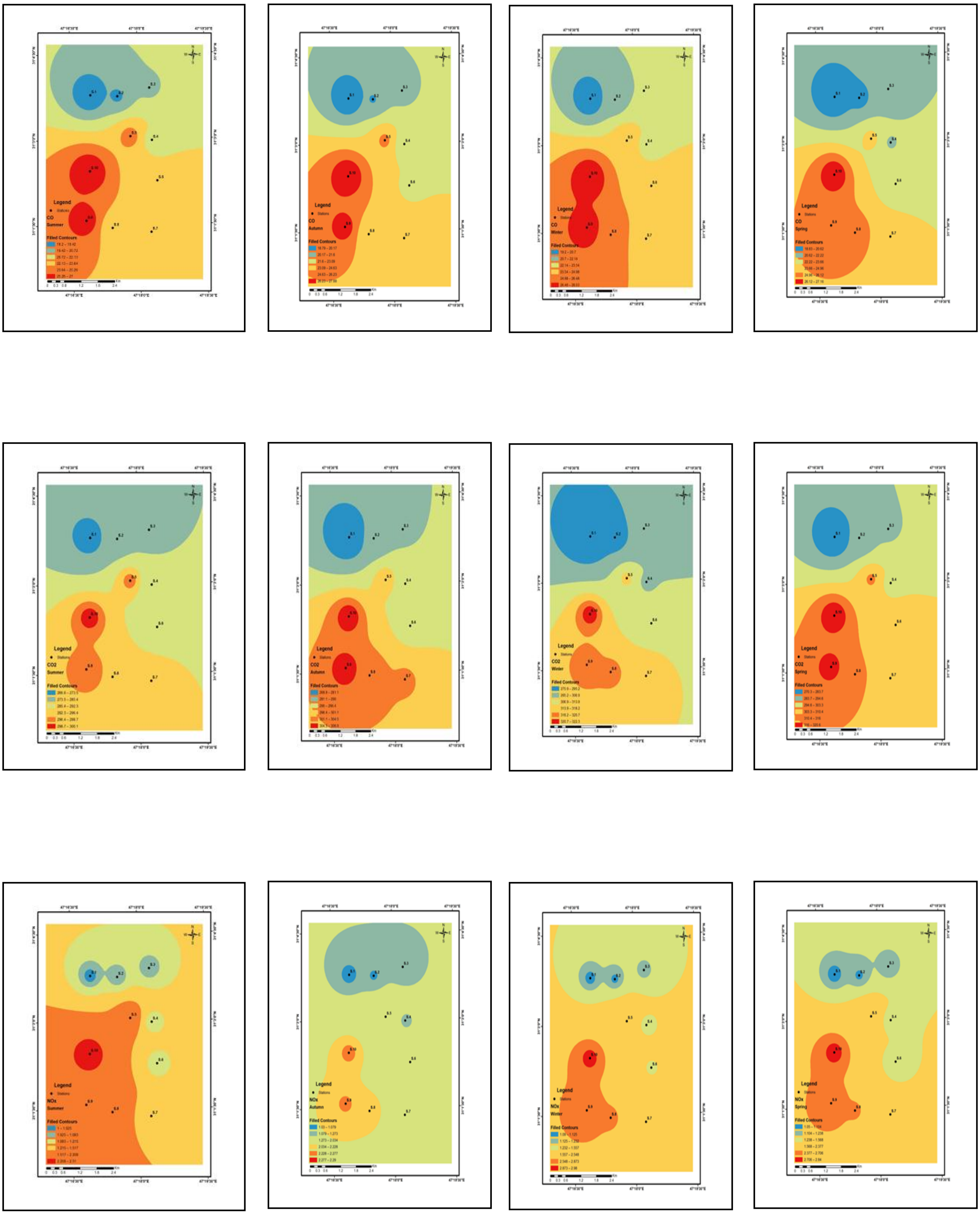
The results of the regional mean concentrations of the gasses at present study show that: The highest concentration of the gases (CO, CO_2, NOx, SOx, H_2S, CH_4 and HCs) is at station 10 (27.517, 312.475, 2.655, 3.15, 3.367, 14.597 and 14.060 ppm) and the lower at station 1 (18.755, 270.4, 1.042, 2.227, 2.36 , 11.765 and 11.240ppm) (Tables 1,2,3,4,5,6 and 7) while The highest mean concentration of O_3 gas is at stations5, 9 (0.1ppb) and the lower in station 1 (0.08ppb) (Table 8).

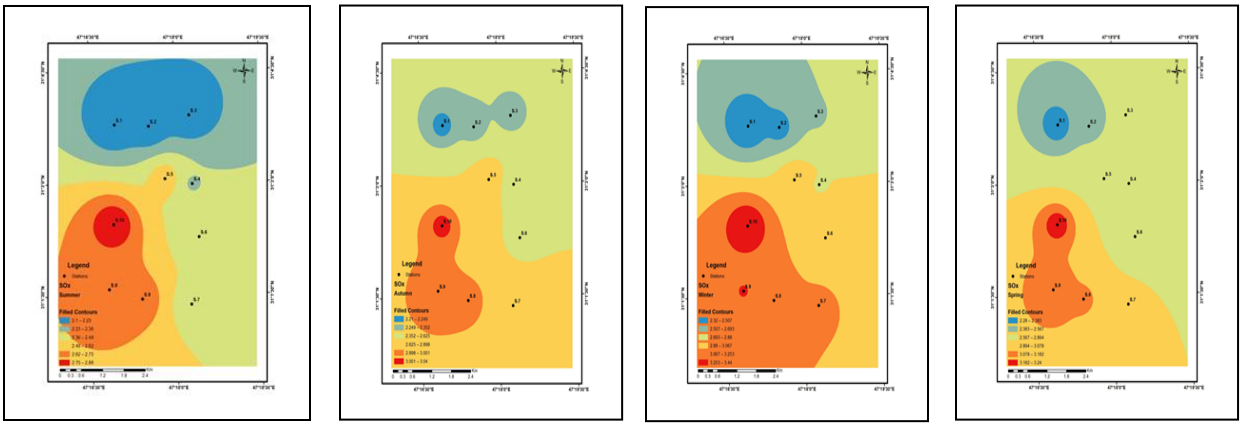
The results show that there is a variation in the recorded concentrations of all the monitored gaseous pollutants. They gradually increase starting from the sampling station 1 until station 5, and then significantly decrease at station 6 and then increase to station 10. This is due to the distance from the flame of flare. In general, station10 records the higher concentrations when compared to the other studied stations. This is due to the location of its existing near the flame (Fig. 2,3,4,5,6,7,8 and 9).

The anthropogenic source is divided into stationary and mobile sources. The stationary sources in study area include major industrial plants such as Hartha and Najebia Thermal Power Stations, and minor industrial plants such as gas-fueled power stations, gas flames, etc. These sources, in total, emit from their smokestacks into local atmosphere thousands of metric tons of gases in every day. Recently, the automobile exhausts become the predominant mobile source of gaseous emissions, because they largely increase in traffic. All of these sources cause higher emission problems to the environment [14].

The result of the seasonal gasses shows that the highest mean of the gasses gases (CO, CO_2, NOx, SOx, H_2S, CH_4, HCs and O_3) concentrations are recorded during Winter (23.946, 307.58, 1.898, 2.921 , 3.131, 13.731, 13.508 ppm and0.104ppb respectively) while the lower is during Summer (22.389, 289.09, 1.49, 2.432, 2.457, 12.468, 12.076 ppm and 0.084ppb), the seasonal concentrations arrange as following: Winter >Spring >Autumn>Summer (Table 1,2,3,4,5,6,7 and 8).

The result indicates that the average concentra-tions of the monitored gaseous pollutants are higher in the Winter than those recorded in the Summer. This may be primarily attributed to the differences in weather conditions, especially wind speeds and directions, air temperature, and humidity, the present result is in agreement with [19] who found that gaseous pollutants are higher in the Winter than those recorded in the Summer. Based on our data, the GIS maps represent the concentrations of Gasses measured during different seasons (Fig. 9)

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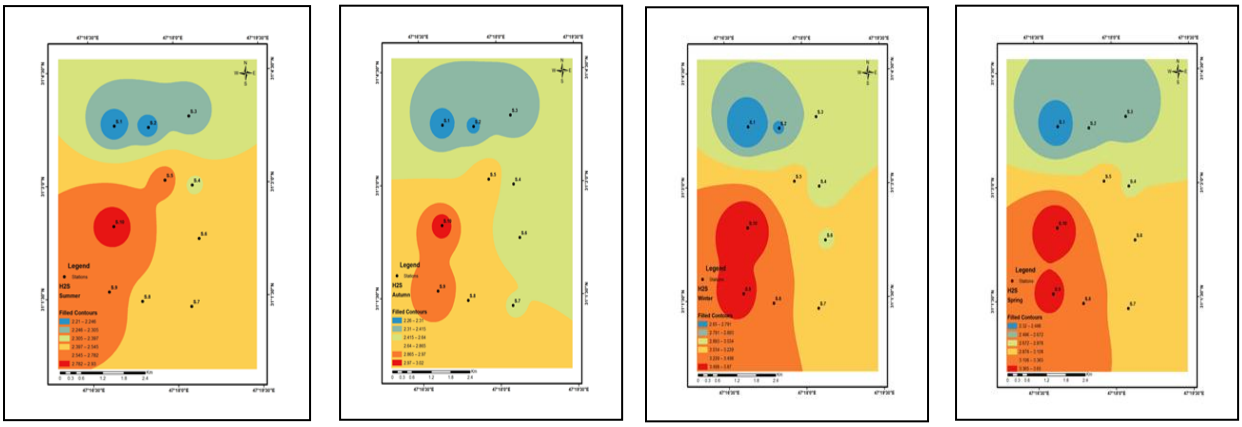
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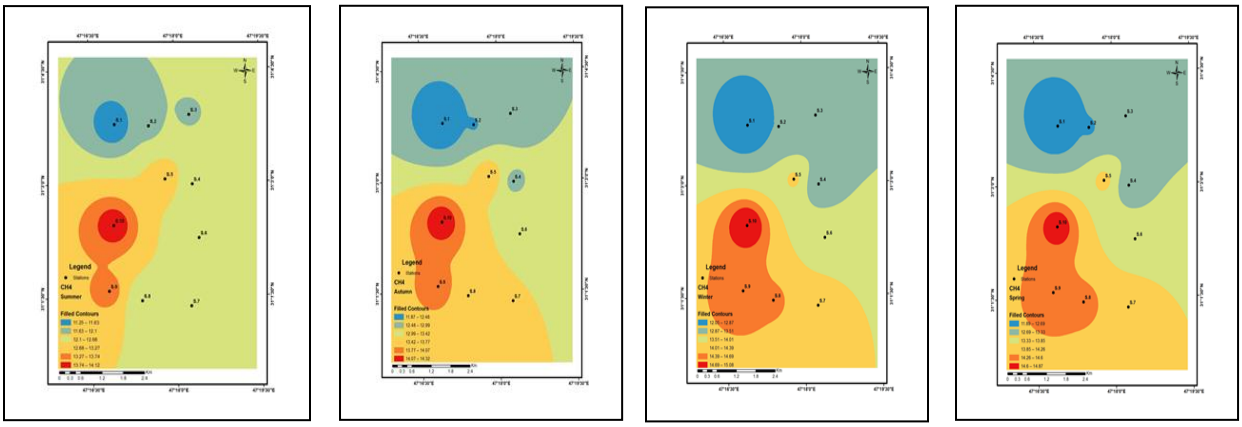
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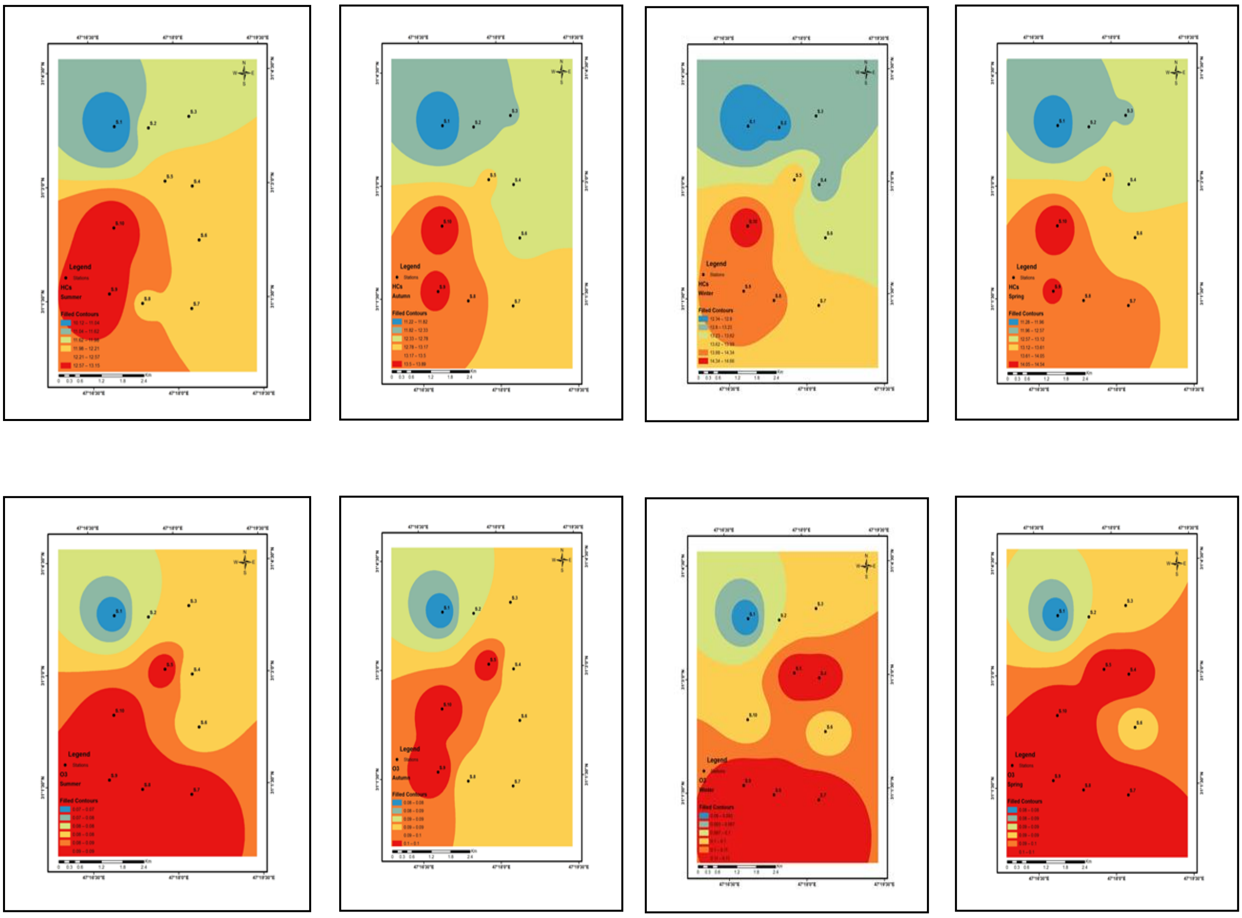

Fig. 9: GIS map showing Gasses distributions in Air of West Qurna 2-oil field for different seasons

Table 9: Comparison between the results (minimum and maximum concentration) in the present study and the recommended guidelines

CO (ppm)	CO_2 (ppm)	NOx (ppm)	SO_2 (ppm)	H_2S (ppm)	HCs (ppm)	CH_4 (ppm)	O_3 (ppb)	Ref.
9-35	5000-30000	0.015-0.100	-	-	-	-	0.050	WHO, 2005; 2010 [20 and 21]
9-35	10000	0.53	0.03-0.50	-	-	-	0.075-0.12	USEPA, 2011 [22]
10-35	-	0.04-0.05	0.018-0.1	4.5-9	18	18	0.06	MoE, 2012 [23]
18.20-28.03	266.6-322.3	1.00-2.98	2.10-3.44	2.21-3.87	10.12-14.66	11.25-15.08	0.07-0.11	The present study

The results obtained for statistically correlation found positive correlation between all gasses are (r = 0.613 -0.956).

The comparative analysis reveals that the present minimum and maximum concentrations of CO, NOx, and SOx were higher than the recommended exposure of levels for all the guidelines of WHO, USEPA, MoE. The minimum concentrations of H_2S, HCs, CH_4 and O_3 were within the guidelines, whereas the maximum concentrations of mentioned pollutants exceeded the recommended concentrations. The minimum and maximum concentrations of CO_2, however, were less than the guidelines (Table 9).

Table 10: Comparisons between the results (mean concentration) of present work and those of previous studies

CO (ppm)	CO_2 (ppm)	NOx (ppm)	SO_2 (ppm)	H_2S (ppm)	HCs (ppm)	CH_4 (ppm)	O_3 (ppb)	Ref.
12.5	-	-	1	-	3	-	-	Al-Asadi,1998 [24]
52.5	0.19		22.5	4	15	-	-	Al-Mayahi,2005 [17]
-	174	-	-	-	-	40.5	-	Al-Imarah *et al*,2007[25]
27.3	270	2.51	0.57	11	22	-	0.16	Al-Hassen,2011 [14]
7.37	280	0.35	0.36	-	-	-	-	Kssam,2011[26]
11	255	0.9	0.65	-	0.8	-	-	Douabul *et al,*2013 [19]
25.4	221.87	1.49	3.67	2.45	18.97	12.81	0.08	Sultan *et al,*2013 [3]
15.30	235.61	1.15	2.18	2.19	14.01	12.58	0.08	Al-Hassen,2015 a [2]
≥ 150	2426	12.6	0.7	≤ 0.2	42	-	-	Al-Hassen,2015b [5]
18.20-28.03	266.6-322.3	1.00-2.98	2.10-3.44	2.21-3.87	10.12-14.66	11.25-15.08	0.07-0.11	The present work

Table 10 shows a comparison between the results in the present work and the previous studies. The comparison demonstrate that there is significant variability in the registered values between this study and those which for others. This may refers to the differences in the adopted measuring durations, instruments, and procedures.

CONCLUSION

The regional highest concentration of the gases (CO, CO_2, NOx, SOx, H_2S, CH_4 and HCs) are at station 10 and the lower at station 1, while the highest mean concentration of O_3 gas is at stations5, 9 and the lower in station 1.The result of the seasonal gasses showed that the highest mean of the gasses gases (CO, CO_2, NOx, SOx, H_2S, CH_4, HCs and O_3) concentrations is recorded during Winter season, while the lower is during Summer season.

CONFLICT OF INTEREST STATEMENT

Authors declare that they have no conflict of interest.

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