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Survey of Air Quality and Health Risk Assessment Around East Baghdad Oil Field, Iraq

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Abstract

Air pollution evaluation of the operational processes in the East Baghdad oil field was carried out. The analysis was carried out by ICP-MS technique. Total Suspended Particles (TSP) air load was higher than Iraqi Standards and world international allowable limits of World Health Organization. The mean concentrations of gases carbon monoxide, carbon dioxide, sulfur dioxide, in the air were within national and world standards, while the mean concentration of nitrogen dioxide was higher than standard limits. The air of the study area is considered a good quality for CO, CO_2 and NO_2 with no health effect, while it is hazardous for TSP that have serious risk for people with respiratory disease. The mean concentrations of Cd, Cr, Cu and Co were higher than national and world limits due to operation processes and combustion of crude oil in the site while Ni concentration was within limits.

Keywords: Air pollution, Heavy metals, Air Quality Health Index, East Baghdad oil field.

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Survey of Air Quality and Health Risk Assessment Around East Baghdad Oil Field, Iraq

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تحري نوعية الهواء وتقييم المخاطر الصحية حول حقل شرق بغداد النفطي، العراق

إنعام جمعة عبد الله و مينا سعد محمد

قسم علم الارض – كلية العلوم – جامعة بغداد

الخلاصة

تم اجراء تقييم تلوث الهواء لموقع تشغيل حقل نفط شرقي بغداد النفطي تم استخدام تقنية ICP-MS . كان معدل تراكيز الدقائق العالقة الكلية في الهواء اعلى من المحددات المحلية العراقية والعالمية لمنظمة الصحة العالمية بينما كانت تراكيز غازات اول و ثنائي اوكسيد الكاربون و ثنائي اوكسيد الكبريت ضمن المحددات المحلية والعالمية اما ثنائي اوكسيد النتروجين كان اعلى من المحددات اعلاه. و يعتبر هواء منطقة الدراسة جيد النوعية من ناحية الغازات و بدون تاثير صحي خطر و لكنه غير صحي بالنسبة لمحتواه من الدقائق العالقة الكلية و يسبب مشاكل للاشخاص ذوي الامراض التنفسية. وكان معدل تراكيز عناصر الكادميوم، الكروم، النحاس و الكوبلت اعلى من المحددات اعلاه و ذلك نتيجة لعمليات حرق النفط الخام بينما كان تركيز النيكل ضمن الحدود المسموحة.

الكلمات المفتاحية: تلوث الهواء، العناصر النادرة، مؤشر جودة الهواء الصحي، حقل نفط شرق بغداد.

Introduction

Air pollution origin either from normal or man-made. Natural resources contain volcanoes, forest fires, pollen and dust. Man-made sources of air pollution contain industry, power generation factories and vehicles, including cars, trucks, trains, airplanes and ships. The main provenance of particulate matter pollution worldwide comprise; wood combustion and ground clearing, transportation, and industrial sources, particularly power generation. Air pollutant concentrations vary considerably, depending on the closeness of the pollution source, the source strength, meteorological conditions and the reactivity of the atmosphere [1].

The purpose of this study is to evaluate the risk heavy metals pollution for air and illustrate the distribution of pollutants also classify air quality using pollution indices within the production units and the area around the east Baghdad oil field.

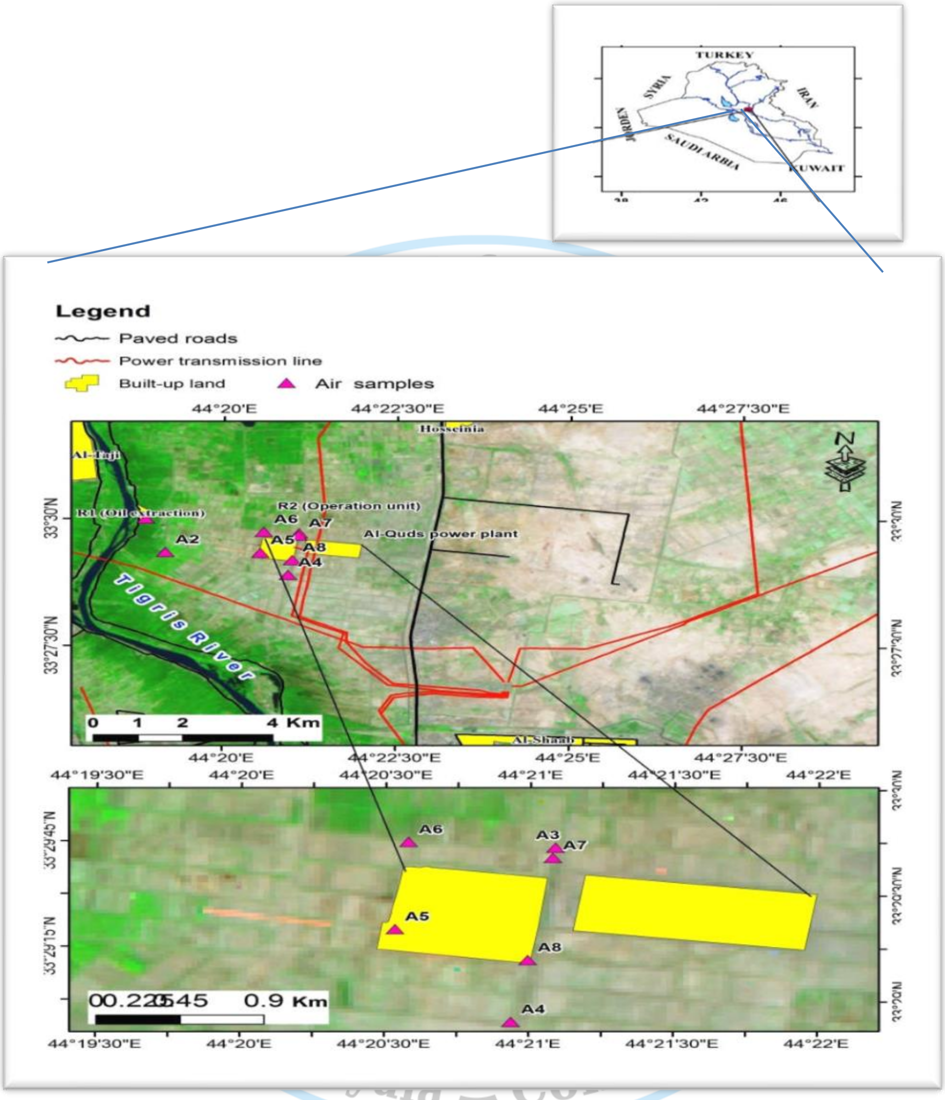

Figure 1: Air Sampling Locations of the study area

Material and methods

East Baghdad oil field lies between latitude (44. 31 877-44.35 04) and longitude (33.50312 - 33.48871) as showing in figure 1. According to the longitudinal tectonic classification of Iraq the studied area is located at the Middle part of Iraq within the Mesopotamian basin of the unstable shelf [2]. East Baghdad oil field gained great importance given to contain his column contrapuntist many reservoirs rocks and especially Cretaceous rocks that form the basic and important reservoirs in this field [3]. Eight samples were taken with direction of winds from inside and outside of east Baghdad oil field, figure 1. The collecting completed by using Low Volume Sampler (Sniffer). Total suspended particles (TSP) in the filters were determined following [4].

The concentration of heavy metals in the filters have been analyzed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Limits of some gases including (CO_2, CO, NO_2 and SO_2) were measured in 8 locations by using portable device in the field.

Results and Discussion

Total Suspended Particulate (TSP) is a mixture of liquid droplets and small particles either organic or inorganic substances. Particulate is a molecule that is bigger than 0.0002 μm but smaller than 500 μm which is formed as airborne solids or liquids [5].Those small particles can also have other chemical reactions to form secondary pollutants hazardous, which will be more harmful to the environment such as the case of the increase darkness of the atmosphere caused by suspended particles due to the blocking of the sun's rays [6].These particles have the ability to suspend in the air for a period of time varying from few seconds to several months, depending on their size and can eventually exist everywhere either on air, water and solid surfaces [7,8]. According to, the health risk these particles may affect the exchange of oxygen and carbon dioxide in the blood, causing restriction of breath, chocking the heart. Mankind most slender to these circumstances comprises those with heart troubles, or respiratory illness.

The old people and kids are much susceptible [9]. Total suspended particles recorded for the study area ranged from (1589.02 to 4302.72) μg/m3. The with mean (3064.19) (μg/m3) was very higher than the permissible limits of the determinants of the Iraqi and health organization limits table 1.

The maximum value recorded for TSP was (4302.72) µg/m3 at A7 station, due to its location with prevailing wind direction from northeast to southeast. The minimum value recorded was (1589.02) µg/m3 at A1.

Table 1: Range and Mean of TSP in Compare with Iraqi and World Limit Standards.

Station No.	TSP (µg/m3)
A1	1589.02
A2	2512.53
A3	2906.97
A4	3095.23
A5	3087
A6	3658.73
A7	4302.72
A8	3361.34
Range (µg/m3)	3087-4302.72
Mean	3064.19
[10] Iraqi standards, 2008 (µg/m3)	350
[11] WHO, 1996(µg/m3)	60-90

Carbon monoxide (CO) is deleterious if inhaled because it replaces oxygen in the blood and deny the heart, brain, and other lusty members of oxygen. Great levels of CO cause collapse awareness and asphyxiate. A side from narrowness upon the chest, primary symptoms of CO poisoning implicate headache, fatigue, dizziness, drowsiness, or nausea [12]. The results of measurements of some gases concentrations, table (2) and figure 2 illustrated that the maximum value at A3 of (5.9 ppm) whereas the minimum value was (2.7 ppm) at A8 with a mean value of concentrations of recorded CO in the study area was (4.2 ppm). Comparing the concentrations of CO results with local and world limits, concentration never exceeded the limits in all measurement sites, table 2 and figure 2**.**

Carbon Dioxide (CO_2) have emission from fossil fuels such as oil, char, and natural gas were initial burn to inspire power for electricity and carriage fuel [13]. Exposure can also cause dizziness, headache, sweating, fatigue, numbness and tingling of extremities, memory loss, nausea, vomiting, depression, confusion, skin and eye burns [14]. By reference to the results of

Diyala Journal for Pure Science

gases concentrations in the air of the study area, as illustrated in table (2) and figure 2, the maximum concentration of (CO_2) was (149) ppm in site A7, and the minimum concentration was (111) ppm in site A6. The mean value of concentrations CO2 was (125.375) ppm which is lower than allowed concentrations in the [10] and [11].

Nitrogen Dioxide (NO_2) have emission from the burning of fossil fuels and biomass are the ultimate significant provenance of atmospheric nitrogen, and it is evaluated that 5-10% by volume of total NOx release in the form of NO_2. Nitrogen dioxide can trigger the lungs and respiratory contagion such as influenza; it can lower the blood's capability to hold oxygen over the body, proceed headache, fatigue, dizziness, and a blue color to the skin and lips. The result of gases concentrations listed in table (2), which means value (4.03) was higher than the [10], [11] and [15] where the maximum value is (4.3 ppm) at A6 and the lowest value is (3.7ppm) at A4, figure 2.

Table 2: Concentration of gases and comparing with local and world limits.

Station	*CO ppm*	*CO_2 ppm*	*NO_2 ppm*
A1	5	127	3.9
A2	4.9	117	4.1
A3	5.9	144	4
A4	3.6	122	3.7
A5	3.7	118	3.9
A6	3.5	111	4.3
A7	4.3	149	4.2
A8	2.7	115	4.2
Range	2.7-5	111-149	3.7-4.3
Mean	4.2	125.37	4.03
Iraqi standards, 2008	35 ppm	250 ppm	0.25 ppm
WHO, 1996	9 ppm	250 ppm	0.11 ppm
EPA,1995	35 ppm		0.53 ppm

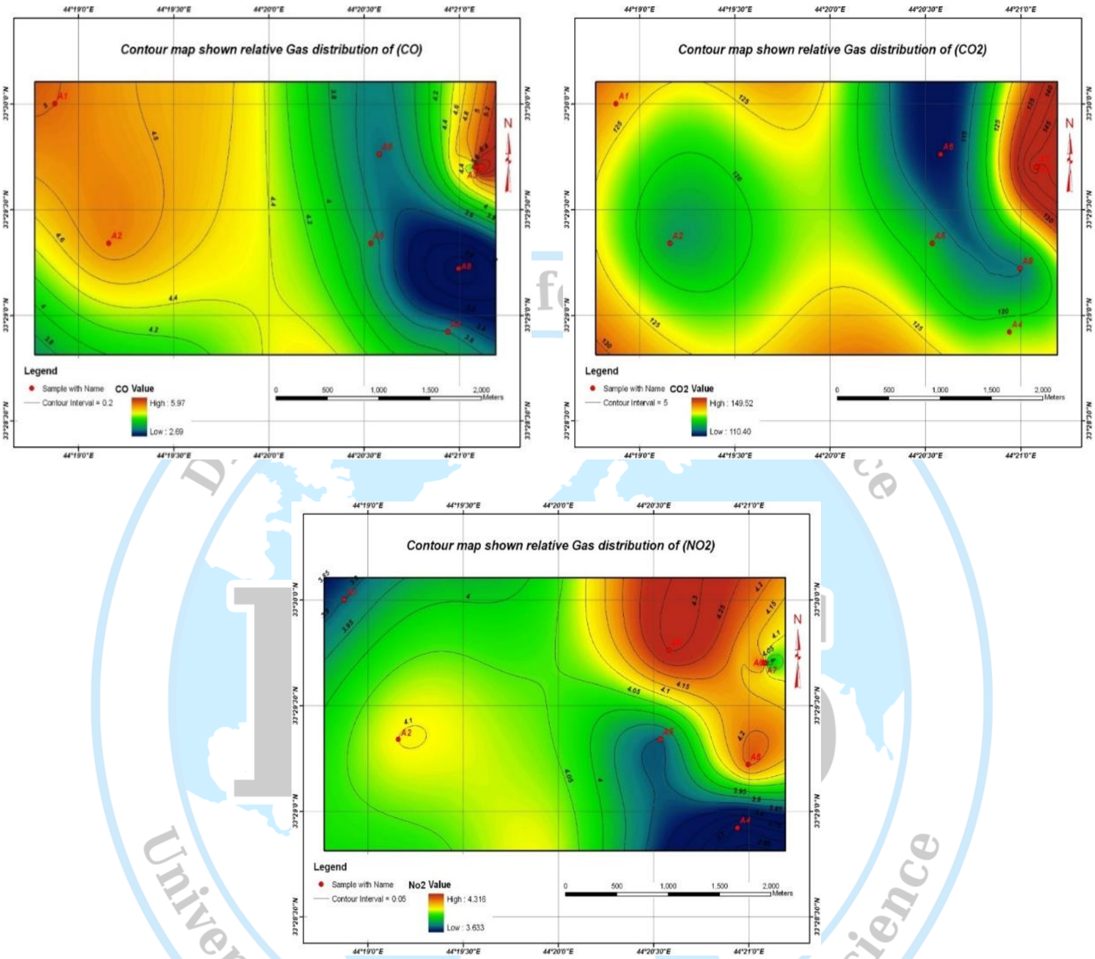

Figure 2: Distribution concentrations of CO, CO_2 and NO_2 gases in the air of study area

Heavy metals are types of pollutants that have a great potential harm to ecological environment. They usually cannot be biodegraded when released into the environment [16]. Heavy metals are carried in the atmosphere as gases, aerosols, and particulates [17]. It could be tinny and large size; fine particles proceed huge health risk than the coarse particles because they stay suspended in air for long time from few hours to weeks [18]. The content of heavy metals in the air shown in table 3 and Figure 3.

Arsenic (As) the existence in the atmosphere from soil dusts, volcanic explosion, sea salt aerosols, forest fires and coal burning [19, 20]. Exposure to arsenic can cause many health problems, such as irritation of the stomach and intestines, lowered the output of red and white blood cells, skin changes and lung irritation [14]. The concentrations of as in all stations of the study area were (<0.50) µg/m3. Boron (B) is also emitting from manmade sources to a lesser range. Anthropogenic sources contain agricultural, and fuel combustion, power generation using coal and oil [21]. Great levels of boron may strike the stomach, liver, kidneys and brains and can ultimately procure to death. While exposure to lesser levels of boron introduce irritation of the nose, throat or eyes [14]. Boron ranged from (1280) to (3760) µg/m3 with mean value (3003.75) µg/m^3.

Table 3: Concentration of heavy metals in air of the study area

Element	*Range (µg/m^3)*	*Mean (µg/m^3)*	*[10]Iraqi standards, 2008 (µg/m^3)*	*[11]WHO, 1996 (µg/m^3)*	*[15]EPA,1995 (µg/m^3)*
As	<0.50	<0.50			
B	1280-3760	3003.75			
Cd	0.444-0.723	0.612		0.05	
Cr	0.46-0.63	0.52625		0.04	
Co	0.31-0.59	0.47875			
Cu	0.68-1.12	0.83875		0.25	
Pb	3.79-6.28	5.16375	3	0.5	0.15
Mn	2.52-4.29	3.625			
Mo	<0.50	<0.50			
Ni	<0.50	<0.50		0.2	
Se	<0.50	<0.50			
V	<0.50	<0.50			
Zn	1780-3080	2551.25		6	

Cadmium (Cd) in the atmosphere comes from mankind activities [22]. The industrial sources are ferrous and non-ferrous metallurgical facilities, waste incineration, cement kiln, fossil fuel combustion, wear of vehicle tires, pigment production, and metal scrap smelting and refining. Fossil fuel burning, oil refining power plants and metal industries are accountable for great Cd emissions to the atmosphere [23]. Critical exposures hardly injury the lungs, thus may give rise to death [14]. The mean value of cadmium concentration was (0.612) µg/m^3in the atmosphere of study area was higher than [11] limit, table3. The higher concentration of Cd site A1 (0.723) µg/$m^3$and this may due to its location in the way of the prevailing wind, while the lowest concentration was at site A5 (0.444) µg/m^3.

Anthropogenic sources of Chromium (Cr) largely from fuel burning, give a share up to 70% of Cr to the atmosphere. Inhalation of chromium caused bronchitis, less pulmonary function, pneumonia, and other respiratory problems, chromium is a human carcinogen, produced high likelihood risk of lung cancer [24]. The mean concentration of Cr in the study area was (0.52625) µg/m^3, which is higher than [11] limit (Table 3). The higher concentration was at A1 (0.63) µg/m^{3}and this may due to its location in the way of the prevailing wind while the lower concentration was (0.46) µg/m^{3}at A5.

Cobalt (Co) emit into the atmosphere in low levels from fuel power plants and incinerators, vehicular exhaust, mining industrial activities, ore exploration, cobalt alloys manufacturing and chemicals. Cobalt has both beneficial and harmful effects on human health. Inhalation of large amounts of cobalt caused respiratory problems, such as a lesser in ventilation function, and lung hemorrhage [25]. The mean concentration of cobalt in the atmosphere of study area was (0.47875) µg/m^3, Table 3. The higher concentration of Co was detected at A1 (0.59) µg/m^3, while the lower concentration was (0.31) µg/m^{3}at A5.

Copper (Cu) in the atmosphere sources from melting of various ores, burning of fossil fuels, foundries, kiln processes for the production of cement, used of fertilizers and domestic sewage to the land and industrial factories. Natural sources of Cu are: eroded rocks, volcanoes, thermal springs and aerosol dust from continent terrestrials [26]. Exposure to copper fumes, aerosol, or dust caused alteration in nasal mucous membranes. Inveterate copper intoxication caused Wilson’s disease, described by a hepatic cirrhosis, brain damage and renal disease [14]. The mean value of Cu concentration in the study area was (0.83875) µg/m^3, higher than [11] limit table 3. Higher concentration was at A8 (1.12) µg/m^3, while the lower concentration was at A4 (0.682) µg/m^3.

Lead (Pb) emit to the atmosphere from natural and industrial emissions, such as; fuels burning in electric power generation sites, gasoline incineration, roasting and smelting activities, and waste burning and cement manufacturing [19]. Rely on the limits of exposure, lead can

Diyala Journal for Pure Science

adversely affect the nervous system, kidney task, immune system, reproductive and developmental systems and the cardiovascular system [9]. The mean value of Pb concentration in the study area was (4.64375) µg/m^3, which is higher than national and global standards, Table 3. Higher concentration of Pb was at A3 (5.7) µg/m^3, while the lower concentration was at A1 (1.12) µg/m^3.

Nickel (Ni) resources are windblown aerosols and volcanoes emissions, while anthropogenic sources are combustion residue of the fuel, and Ni alloy refining [26]. The grave hurtful health risks from exposure to nickel, like chronic bronchitis, decrease lung function, lung cancer and nasal sacs [25]. The concentrations of Ni in the study area were (<0.50) µg/m^3.

Manganese (Mn) in the atmosphere is from both earthy and manufacturing sources [26]. The world atmospheric emit from ferric metal melting, and fuel burning. Inspiration of manganese is toxic to the lungs, and performed an infection's reaction that accretion ability to pneumonia and bronchitis, manganese may cause a neurologic problem always non- recognizable from Parkinson's disease [27]. The mean value of Mn concentration in the study area was (3.625) µg/m^3. Higher value was at A2 (4.29) µg/m^3, while the lower value was at A1 (2.52) µg/m^3.

Molybdenum (Mo) released to the environment both from natural ways and from manmade activities like the combustion of fuels [26]. Inhalation of molybdenum aerosols and dust caused eyes irritation and the mucous membranes. Skin touch with molybdenum dust may cause irritation [9]. The concentrations of (Mo) were (<0.50) µg/m^{3}in all stations.

Selenium (Se) released to the environment by both natural ways and from manmade activities during fossil fuel burning; levels of Se in the atmosphere are largely varies due to many sources: (i) vaporization from ocean and sea surface, (ii) volcanic eruption, and (iii) industrial emissions [26]. Inhalation results primarily in respiratory problems, such as irritation of the mucous membranes, pulmonary edema, severe bronchitis, and bronchial pneumonia [24]. The concentrations of (Se) were detected (<0.50) µg/m^{3}in all stations.

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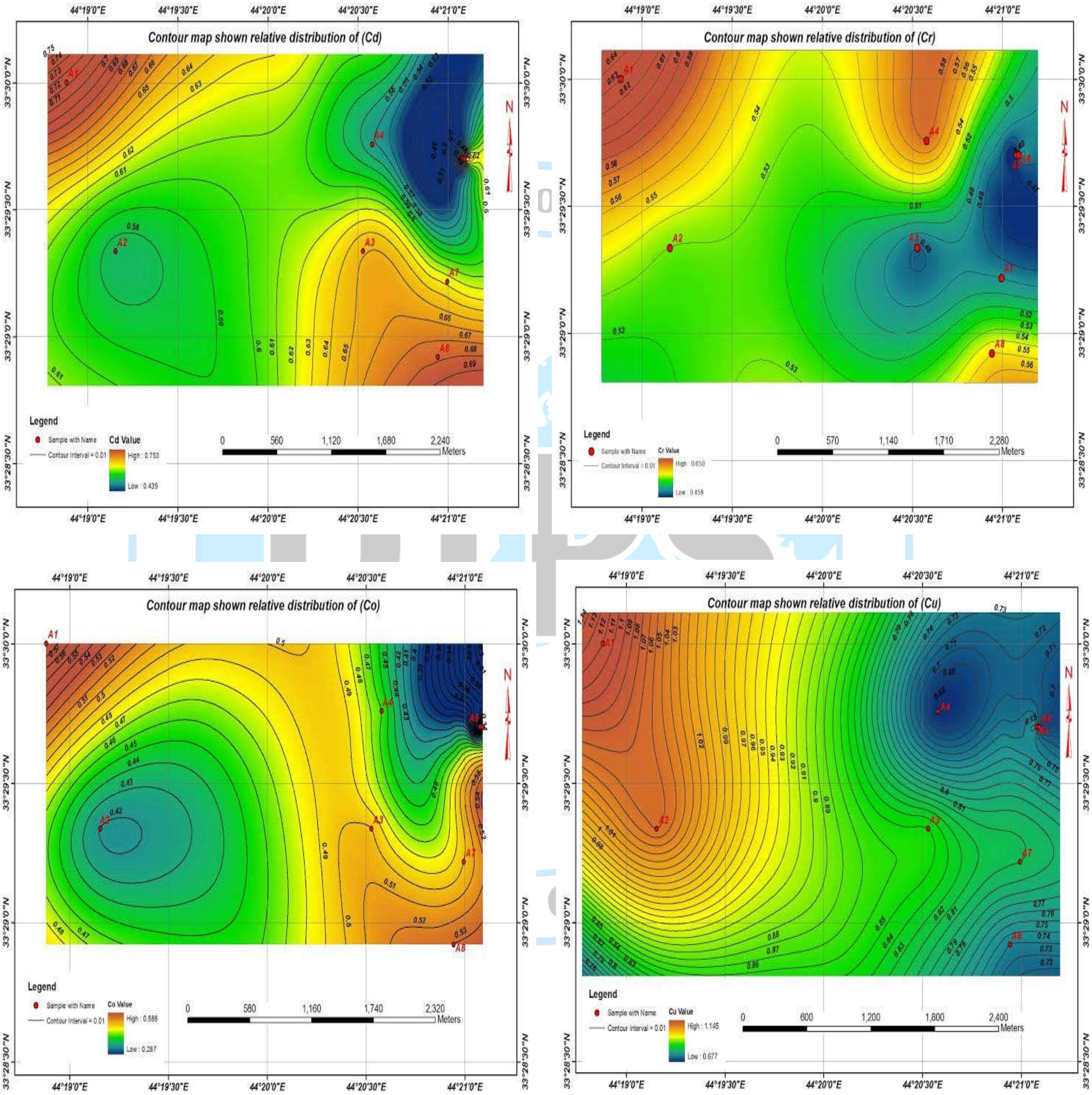

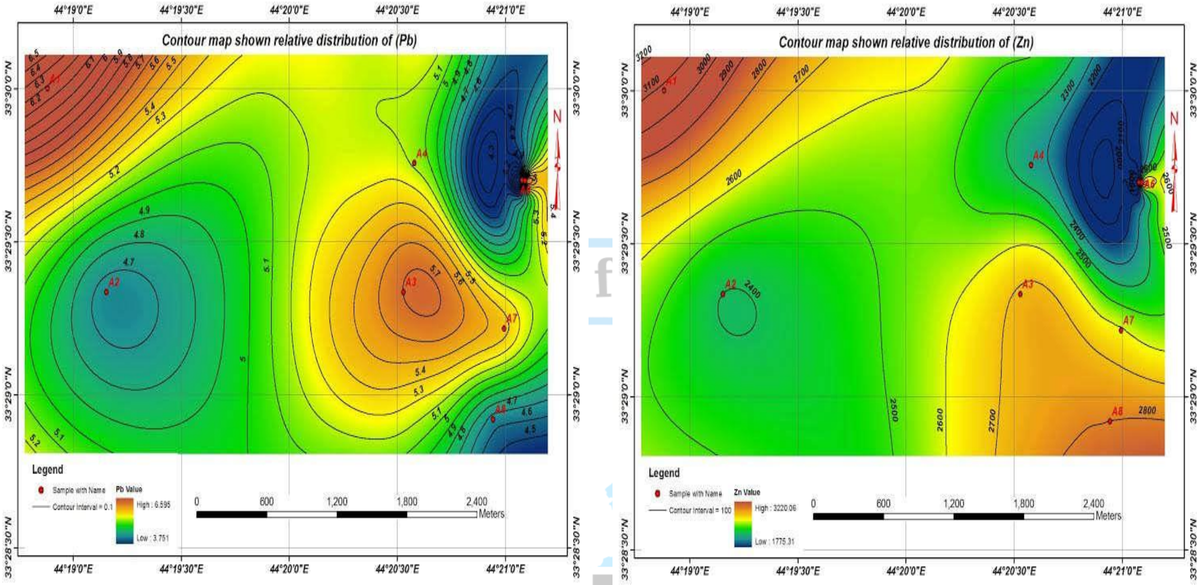

Figure 3: Concentrations distribution of some trace element in the air of the study area

Vanadium (V) released to the environment both natural ways and from manmade activities like combustion of coal, wood, solid wastes etc. vanadium has long life time in air, water, and soil. Vanadium does not dissolve in water. It links highly to soil and sediments [28]. Inspiration of large levels of vanadium in air may cause lung damage [24]. The concentrations of (V) were (<0.50) µg/m3in all stations.

Zinc (Zn) limits in the air are low and less constant; Zinc released to the atmosphere as volatiles and aerosols from industrial activities, combustion of waste, cements manufacturing, and from fuel burning power plants [26]. The mean value of Zn concentration in the study area was (2551.25) µg/m3and, it is much higher than WHO limits. The higher concentration was (3080) µg/m3 at A8, while the lower concentration was (1780) µg/m3at A1.

Diyala Journal for Pure Science

Air Quality Health Index

The AQI is an index for inform daily air characteristic, with health risks for human. The AQI converge on health problems that may take place through hours or days exposure to polluted air. EPA rank the AQI for five main air pollutants recognized as the Clean Air Act: ground-level ozone, particle pollution Air quality directly affects, carbon monoxide, sulfur dioxide, and nitrogen dioxide. EPA has determined national air quality standards to safeguard human health [9]. Applying the Air Quality Index for the air of the study area, considered a good quality for CO, CO2 and NO2 with no health effect. While it is hazardous for TSP that have serious risk for people with respiratory disease, table 4.

Table 4: Classification of the study area air according to EPA Guideline.

Variables	*CO ppm*	*CO_2 ppm*	*NO_2 ppm*	*TSP($\mu g/m^3$)*
Mean	4.2	125.37	4.03	3064.19
Air Quality Index (AQI)	48 (good)		4 (good)	Hazardous
Health Effects	None	----	none	Individuals with respiratory disease are highly at risk.
Sensitive Groups	Individuals with heart disease are highly at risk	-----	Individuals with asthma or other respiratory problems, the old, and children are highly at risk.	Serious risk of respiratory disease and stir of lung risks, such as asthma; respiratory effects probable in common inhabitance

Discussion

The mean content of Total Suspended Particles (TSP) in the air is (3064.19) $\mu g/m^3$, which is more than Iraqi standards and world allowable guideline. High TSP in the air is most probably comes from operational processes in the site of the oil field and the adjacent power plant beside the field. It seems that the most abundant direction for gases (CO_2) concentration exceeds towards the north east side of the field where the most active process units are located and the almost wind direction in most days of the year. The mean concentrations of CO, CO_2 in the air are (4.2) and (125.37) ppm, respectively, which are lying within national and world standards, whereas SO_2 was below detection limits and the mean concentration of NO_2 was (4.03) ppm, which is higher than local and global limits, probably it comes from combustion of crude oil in the field and adjacent power plant. The mean content of Cd, Cr, Cu and Pb in the air are 0.61, 0.52, 0.83 and 5.16 μg/m^3respectively, they are higher than global limits, except pb is higher than local and global limits. High concentrations of heavy metals in the air are due to the combustion of fuel and power plants.

The mean and range of the present results were compared with the mean concentrations of the previous local studies like air quality of Baiji City according to [29] and study of [30] of Kirkuk oil refinery (Table 5). The results show significant variations of TSP that is much higher than [30]and [29], gases of present study are higher than local studies, except CO_2 that is lower than limits. Cd, Cr, Co, Cu and Pb are higher than local studies except Ni is within limits.

Table 5: Comparison of the present results with previous local studies.

Variables	*Range (μg/m³)*	*Mean (μg/m³)*	*[29]Abed, 2015*	*[30]Ali, 2013*
TSP (μg/m3)	3087-4302.72	3064.19	357.3	824.415
CO ppm	2.7-5	4.2	0.68	2.325
CO2ppm	111-149	125.37	239.6	339.22
NO2ppm	3.7-4.3	4.03	0.57	0.9545
As	<0.50	<0.50		
B	1280-3760	3003.75		
Cd	0.444-0.723	0.612	0.0622	0.0955
Cr	0.46-0.63	0.52625	0.0266	0.489
Co	0.31-0.59	0.47875	0.0074	
Cu	0.68-1.12	0.83875	0.0129	0.0725
Pb	3.79-6.28	5.16375	0.2258	2.6025
Mn	2.52-4.29	3.625		
Mo	<0.50	<0.50		
Ni	<0.50	<0.50	0.1785	0.5505
Se	<0.50	<0.50		
V	<0.50	<0.50		

Conclusions

The air of the study area have total suspended particles with a mean higher than national and world limits due to the operational processes in the area. The mean concentration of CO, CO_2 and SO_2 were within national and world limits while the mean concentration of NO2 was higher than the national limits due to combustion of fuel. The mean concentrations of Cd, Cr, Cu and Co were higher than national and world limits due to operation processes and combustion of fuel in the site while Ni concentration was within limits. The air of study area considered good quality for CO, CO2 and NO2 with no health effect while considered hazardous for TSP with health risks.

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