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Air Quality Over Baghdad City Using Ground and Aircraft Measurements.

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Abstract

In this paper, the air pollutants concentrations measurements such as Total Suspended Particles(TSP), Carbon Monoxides(CO),Carbon Dioxide (CO_2) and meteorological parameters including temperature (T), relative humidity (RH) and wind speed & direction were conducted in Baghdad city by several stations measuring numbered (22) stations located in different regions, and were classified into (industrial, commercial and residential) stations. The results show that the concentrations of pollutants (TSP, CO, and CO_2) have exceeded the air quality standards set by World Health Organization (WHO) and Iraqi limitation in the stations of the Baghdad city. The program (ArcGIS) used to prepare maps of air pollution in Baghdad city, as well as MS Excel used for drawing the concentrations of pollutants in ground and to show changed the concentrations with altitude.

Aircraft measurements of gaseous pollutants including ozone (O_3), Carbone monoxide (CO) , Carbone dioxide (CO_2) and the particulate matter concentrations (PM10 , PM2.5) were conducted in the Baghdad city from (2 January 2014 to 4 Mars 2014),the data of total 10 flight (22 h flight time),the vertical profile of (CO ,CO_2 ,O_3 ,PM10and PM2.5) have been obtained at different altitude over the Baghdad city covering the lowermost troposphere up to 2100 feet altitude above ground level (AGL) during all flights were obtained by A bell 407 aircraft and A king aircraft. The objective was to characterize the spatial and vertical distributions of these air pollutants.The results indicate that the air pollution levels were severe over the Baghdad city. The pollutants concentrations were generally decreasing with altitude in the boundary layer in the flight measurements .These results are valuable for studying vertical distribution characteristics of gaseous pollutants and particulate matters in the boundary layer over the Baghdad city and for providing important basic data to environmental assessment and decision-making. The reasons for this increasing due to increase in anthropogenic emissions, mainly due to the increase in fossil fuel use for heating, the burning of the fuel used in various types of vehicles, as well as the low quality of fuel and the age of the vehicles, the use of generators, the dry climate, soil erosion, lack of roadside vegetation, paved areas, substantial rise in number of vehicles and poorly maintained vehicles have all been held Responsible.

Keywords: air pollution, aircraft measurements, groundmeasurements, ozone, GISand particular matter.

تقييم نوعية هواء مدينة بغداد باستخدام القياسات الارضية وقياسات الطائرة.

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الخلاصة

في هذا البحث تم قياس تراكيز الملوثات الهوائية المتمثلة بالدقائق العالقة الكلية (TSP) واكاسيد الكربون (CO_2 ، CO) في مدينة بغداد من خلال عدة محطات قياس ارضية بلغ عددها(22) محطة موزعة في مناطق مختلفة، وجرى تصنيفها إلى محطات (صناعية وتجارية وسكنية). أظهرت نتائج قياس تراكيز الملوثات الهوائية في مدينة بغداد إن تراكيز الملوثات(TSP,CO,CO_2) قد تجاوزت المحددات القياسية المسموح بها محلياً وعالمياً لملوثات الهواء ولمحطات القياس جميعها. وكذلك تم قياس تراكيز الملوثات الهوائية المتمثلة بالدقائق العالقة (PM10,PM2.5) واكاسيد الكربون (CO_2 ، CO)وغاز الازون (O_3) في مدينة بغداد من خلالتقسيم مدينة بغداد الى اربع مقاطع جوا حيث استخدمت الطائرة في عملية القياس واظهرت النتائج ان تركيز الملوثات الهوائية في مدينه بغداد عالي وان تركيز الملوثات يقل مع زيادة الارتفاع وان تركيز الملوثات الهوائية له ارتباط بموقع القياس. وجرى استخدام برنامج (ArcGIS 9.2) لإعداد خرائط للملوثات الهوائية.

1. Introduction

The airthat a human breathe is a mixture of gases, small solid and liquid particles. Some substances come from natural sources while others are caused by human activities such as our use of motor vehicles, domestic activities, power generation, industry and business. Air pollution occurs when the air contains substances in quantities that could harm the comfort or health of humans and animals, or could damage plants and materials. These substances are called air pollutants and can be either particles, liquids or gaseous in nature [1].The air pollutants can be classified as primary or secondary pollutants. The primary air pollutants are harmful chemicals which directly enter the air due to natural events and human activities.

A secondary air pollutant is a harmful chemical produced in the air due to chemical reaction between two or more components. That is primary pollutant combines with some component of the atmosphere to produce a secondary pollutant [2]. with the rapid industrialization and urbanization after the industrial revolution, human activities accentuated the degradation of air quality for the last several centuries. Severe air pollutant events drew public attention to the influences of air pollutants on human health, and epidemiological studies proved the effects on mortality and diseases [3]. The new trends in environmental knowledge and management are drawing environmental maps of measurements groups and monitoring environmental elements. Computer science begins new and developing horizons in environmental data managements and in taking direct and suitable decisions. GIS is one of the new and developing systems, which become an effective tool in designing and planning [4].This study investigates the air pollution in Baghdad city by using the ground measurements and the aircraft measurements and applications of geographic information system GIS in understanding air pollution.

2. Study area.

Baghdad city is located in central Iraq, within the sector of flat sedimentary plains. The borders of the municipality of Baghdad encompass fourteen administrative units, eight in Rusafa(east of Tigris river) and six in Karkh (west of Tigris river), and area of the municipality of Baghdad (870 km²). Advantages of the characteristics of study area are: essentially great extremism in temperature, little precipitation, low relative humidity and high brightness of the sun. The population of Baghdad is more than 6 million from governmental statistics [5, 6].

3. Methods.

22 measurement stations Figure-1(a) which are distributed in different areas within the municipality of Baghdad were selected for the purpose of measuring the concentration of total suspended particles (TSP), and gases (CO, CO_2) Stations were distributed on a regular basis to cover most areas of the city. Aircraft measurements of gaseous pollutants including ozone (O_3), Carbone monoxide (CO), Carbone dioxide (CO_2) and the particulate matter concentrations (PM10 , PM2.5) and meteorological parameters in Figure-1(b) were conducted in the Baghdad city from (2 January 2014 to 4 Mars 2014),the data of total 10 flight (22 h flight time),the Baghdad city was divided to four sections (A, B, C&D) according to influenced the pollution level of pollutants, the vertical profile of (CO ,CO_2 ,O_3 ,PM10and PM2.5) have been obtained at different altitude over the Baghdad city covering the lowermost troposphere up to 2100 feet altitude above ground level (AGL) during all flights were obtained by A bell 407 aircraft and A king aircraft.

(b) (a)

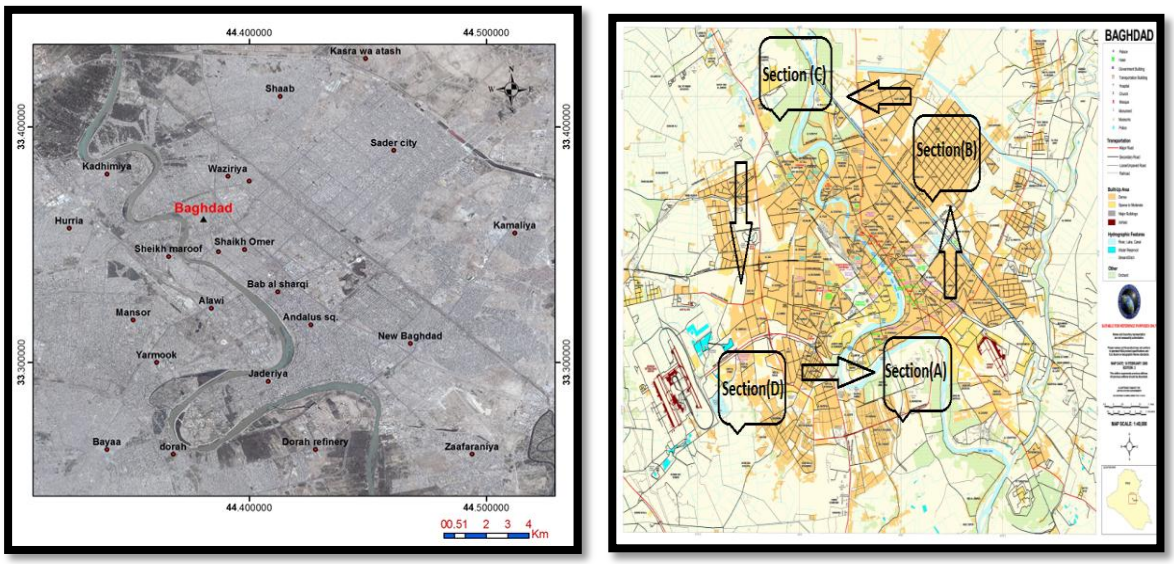


Figure 1- (a) Measurement stations of air pollution in Baghdad city and municipal units. (b)The four flight routes over the Baghdad city.

4. Results and discussion

4.1 The ground measurements

The results of air pollutants concentrations in Baghdad city are shown in Table-1. The highest concentrations of TSP, CO, and CO_2 are recorded in many stations (4, 6, 8, 10, 16, 17, 18), which are characterized by high population and increase in the number of cars as well as poor fuel, the age of the vehicles and industrial activities inside the city.

Table 1-The concentration of air pollutants with in current study.

Station No.	Name of station	Type of station	CO ppm	CO_2 ppm	TSP µg/m³	TEMP c°	Wind speedm / sec	RH %
1	Shaikh Omer	Industrial	32.1	352	1461.8	22	1	56
2	Waziriya	Industrial	42.4	328	1228.7	24	1.1	49
3	Kasrawaatash	Industrial	51.6	325	809.5	27	0.5	43
4	Kamaliya	Industrial	22	327	4025.3	26	1.7	44
5	Sheikh maroof	Industrial	28.3	336	844.3	23	1.5	54
6	Kadhimiya	Industrial	29	355	1979.2	19	0.3	61
7	Dora refinery	Industrial	22.2	320	1029	26	0.9	46
8	Bab al sharqi	Commercial	41.2	375	2379.7	18	0.9	66
9	Bab al moadham	Commercial	36.6	360	1263.3	25	1.5	49
10	New Baghdad	Commercial	37.8	442	3067	21	1	58
11	Andalus sq.	Commercial	35.2	376	810.4	27	0.5	44
12	Alawi	Commercial	28.3	362	768.3	19	1	64
13	Mansor	Commercial	16.3	357	1503.8	23	0.3	55
14	Jaderiya	Commercial	16.9	372	1726.4	20	1.5	63
15	Bayaa	Commercial	26.6	353	1770.5	27	0.5	42
16	Mustansiriya sq.	Residential	50.2	413	2312.1	20	0.4	62
17	Shaab	Residential	49.3	322	5244.7	25	1	45
18	Sader city	Residential	42.7	315	3246	25	1.3	46
19	Zaafaraniya	Residential	18.9	385	3477.3	23	0.5	54
20	Hurria	Residential	12.8	330	1544.2	25	1.5	47

21	Yarmook	Residential	13.7	329	1667.3	24	1.3	48
22	Dora	Residential	25.5	345	2333.1	22	1.5	51

4.2 Aircraft measurements.

Bell 407 aircraft with a cruising speed of about 180 km/h was used for all the flights in section (A) and section (B). A king air aircraft with a cruising speed of about 250 km/h was used for all flight in section (C) and section (D),as show in Figure-2.



Figure 2-The pictures of aircraft left bell 407 and right king air.

Four different flight routes were carried out during the sampling periods. Section (A) flight includes the 2 January, 15 February most of flight shows high concentration of gases pollutants and particular matter. Carbon dioxide concentration ranges from 1.2 ppm at altitude 100 f to 0.006 ppm at 2100 f. Carbon monoxide concentration ranges from 296 ppm at altitude 100 f to 90 ppm at 2100, PM 10 concentration ranges from 28 µg/m³ at 100 f to 10 µg/m³ at 2100 f and PM 2.5 concentration ranges from 10650 µg/m³ at 100 f to 5638 µg/m³ at 2100 f as shown in fig .3 .The results shows the concentrations were highest levels on lowest altitude and decrease with increase of the altitude, the reason of high concentration is the local emission of area that contain on the oil refinery and industrial region, the ozone measurements is also high, the concentration ranges from 110 ppb at altitude 100 f to 51 ppb at 2100 and the reason to the emissions of the VOSc and NOx and present the sunlight intensity in the region.Section (B) flight includes the 9 January, 9 February most of flight shows high concentration of gases pollutants and particular matter.

Carbon dioxide concentration ranges from 0.88 ppm at altitude 100 f to 0.01 ppm at 2100 f. Carbon monoxide concentration ranges from 204 ppm at altitude 100 f to 113 ppm at 2100, PM10 concentration ranges from 27 µg/m³ at 100 f to 5 µg/m³ at 2100 f and PM 2.5 concentration ranges from 9442 µg/m³ at 100 f to 7021 µg/m³ at 2100 f as shown in fig .3 .The results shows the concentrations were highest levels on lowest altitude and decrease with increase of the altitude, the reason of high concentration is the local emission of area that contain on highly populated in the region, industrialized, used the generator and road a traffic. The ozone concentration ranges from 52 ppb at altitude 100 f to 43 ppb at 2100 and the reason to reduce the emissions of the VOSc and NOx in the region.

Section (C) flight includes the 4 February, 4 March in morning, 4 March in afternoon. Carbon dioxide concentration ranges from 0.7 ppm at altitude 20 f to 0.01 ppm at 2100 f. Carbon monoxide concentration ranges from 236 ppm at altitude 20 f to 130 ppm at 2100, PM10 concentration ranges from 64 µg/m³ at 20 f to 4 µg/m³ at 2100 f and PM2.5 concentration ranges from 10410 µg/m³ at 20 f to 5564 µg/m³ at 2100 f as shown in fig .3 .The results shows the concentrations were highest levels on lowest altitude and decrease with increase of the altitude, the reason of concentration is the local emission of area that contain on agriculture in most region and suffer from high levels of particular matter reason to the prevailing wind that come from the north or northwest direction. The ozone concentration ranges from 52 ppb at altitude 20 f to 54 ppb at 2100 and the reason to reduce the

emissions of the VOSc and NOx in the region. Section (D) flight includes 6 January in morning, 6 January in afternoon, and 10 February.

Carbon dioxide concentration ranges from 0.8 ppm at altitude 20 f to 0.1 ppm at 2100 f. Carbon monoxide concentration ranges from 204 ppm at altitude 20 f to 137 ppm at 2100, PM10 concentration ranges from 40 µg/m³ at 20 f to 10 µg/m³ at 2100 f and PM2.5 concentration ranges from 5820 µg/m³ at 20 f to 3021 µg/m³ at 2100 f as shown in fig .3 .The results shows the concentrations were highest levels on lowest altitude and decrease with increase of the altitude, the reason is the local emission of area that contain on airlines way that main reason of pollution. This measurement was characterizing the local variation of air pollution in Baghdad city. The compare between all sections shows effects the local emissions on variation of air pollutants in Baghdad city and influence factors, as show in Figure-3.

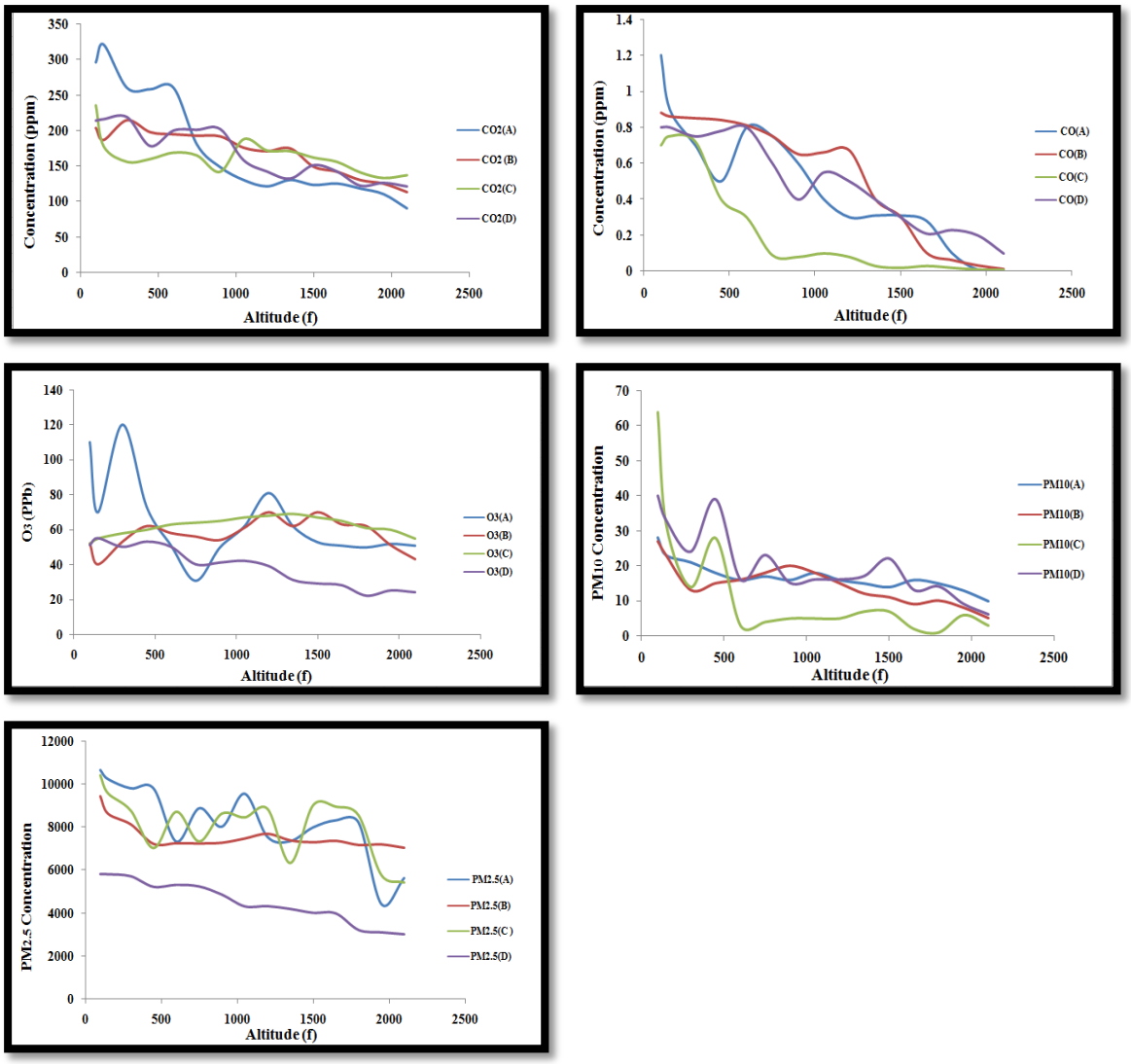


Figure 3-Concentrations of air pollutants by aircraft in Baghdad city.

5. GIS Applications

Spatial analyst provided by (Arc GIS 9.2) has been used, and this is one of the programming packages of GIS in order to analyze the air pollution in Baghdad city and to prepare the distribution maps for it as show in Figure-4.

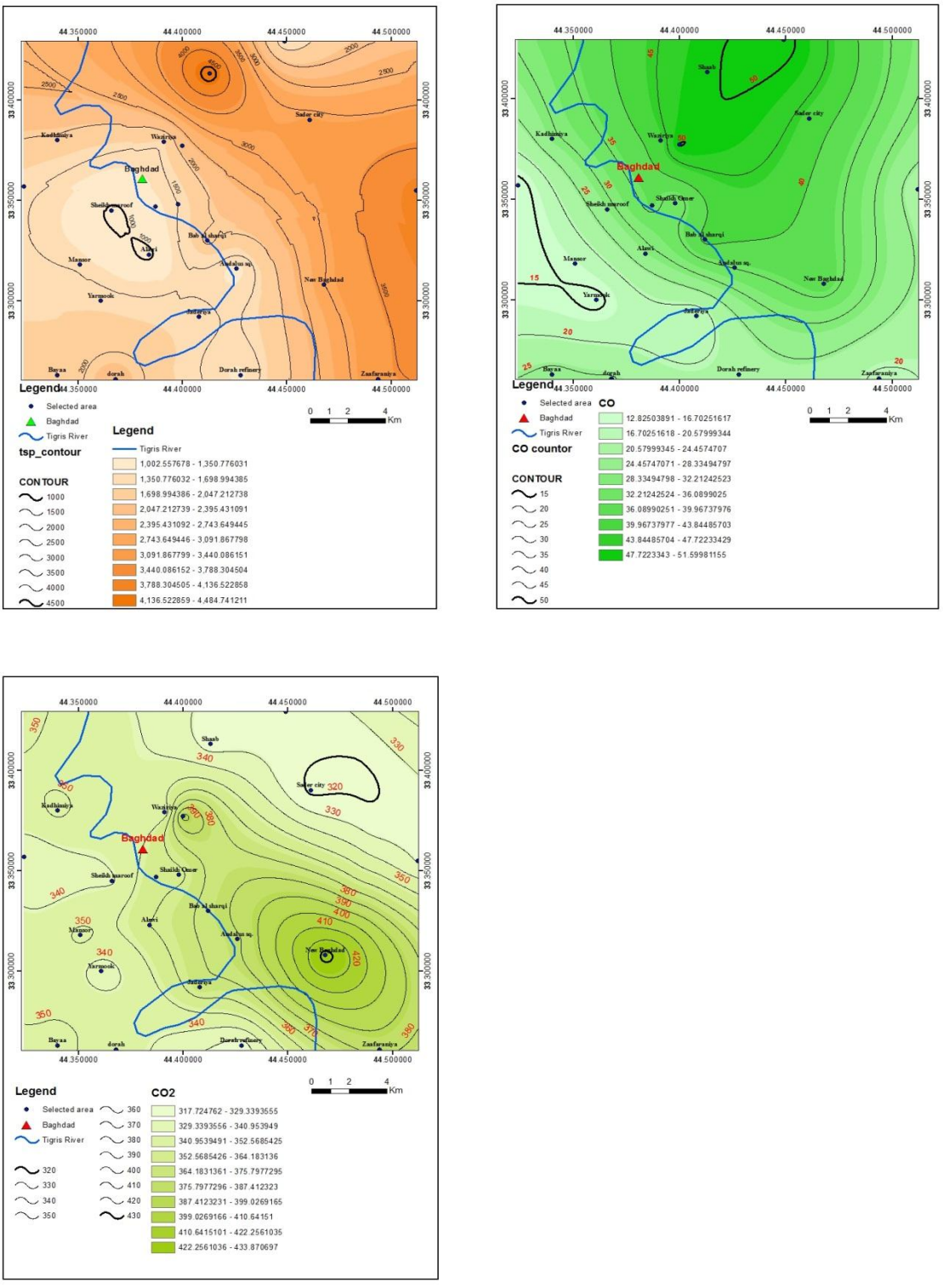


Figure 4-The maps of distribution of (TSP, CO, and CO_2) in the ground measurements by using GIS.

Spatial analyst is considered to be one of the important functions in GIS, this function is used to form maps to illustrate levels of air pollution in the study stations where the measurement of air pollutants concentration is carried out .The pollution levels are divided to classes in order to represent values of air pollutants within Colorgradientsfrom minimum concentration to maximum concentration and for every pollutant of air pollutants at the stations of this study.

6. Conclusions

1. The results indicate that the air pollution levels were severe over the Baghdad city with the concentrations of CO, CO_2 and TSP in the ground measurements, the highest concentrations of TSP, CO, and CO_2 are recorded in many stations (4, 6, 8, 10, 16, 17, 18), which are characterized by high population and increase in the number of cars as well as poor fuel, the age of the vehicles and industrial activities inside the city
2. The pollutants concentrations were generally decreasing with altitude in the boundary layer in the flight measurements.
3. This measurement was characterizing the local variation of air pollution in Baghdad city.

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