Assessment of Air pollution in AL-Nahrawan Suburban- Baghdad city by Geographic Information System(GIS)

Mays Abass
Building and Construction Engineering Department /University of Technology Baghdad.
Email: maysabass@yahoo.com
Dr. Abdulrazzak . T. Ziboon
Building and Construction Engineering Department /University of Technology /Baghdad.
Dr. Zainab Bahaa
Building and Construction Engineering Department /University of Technology /Baghdad.

Received on:14/9/2015 & Accepted on:19/5/2016

ABSTRACT

Urban air pollution is a major environmental problem in all World countries. Air pollution in urban areas may be caused by human activities such as mobility behavior, waste management, industrial development (brick industry, cement industry), production and use of energy (for processing, heating and cooking), and activities which produce dust and suspended particles. The effects of urban air pollution on public health are being felt worldwide. There are a number of factors that influence urban air quality including geographical location, climatological and meteorological factors (temperature, humidity, wind speed and direction), city planning and design, and finally human activities in such areas.

The aim of this study was to measure certain important pollutants (VOCs, SO_2, H_2S, NO_2), and assessing the effect of fuel burning that use in the brick factories. Geographic Information System (GIS) was utilized to map urban air pollution dispersion in AL-Nahrawan suburban – Baghdad city -Iraq. From GIS distribution maps for SO_2 , NO_2 , H_2S and VOCs pollutants , it was found that the value of these gasses were changed from one location to another according to the quantity and quality of fuel used and wind direction. Generally it can concluded that the concentration of measured all examined gasses in the study area was exceeding the WHO and national standards.

Keywords: Urban Air Pollution, Hydrogen sulfide, Nitrogen Dioxide, Sulfur Dioxide , Volatile Organic Compounds, Air pollution, Air quality, National and international limit, Geographic Information System (GIS) .

INTRODUCTION

A great topic of current century is Environmental Pollution at all levels especially air Pollution. Air pollution comes from anthropogenic sources such as burning fossil fuels, i.e. coal, natural gas, and oil-to power industrial processes and motor vehicles. Among the harmful chemical compounds, that release to the atmosphere, are nitrogen oxides (NOx), carbon dioxides (COx), Sulphur dioxide (SO_2), Hydrogen sulfide (H_2S), and ambient solid particles-including several heavy metal ions such as vanadium and lead from gasoline additives-called particulates(PM_1, $PM_{2.5}$, PM_7, PM_{10}).[1]

The air is a mixture of gases and small solid and liquid particles. Some of the substances are caused by human activities while others come from natural source. The substances that are caused by human are domestic activities, motor vehicles, business and industry. Air pollutants are the found to have severed consequence upon both public health and natural environment, However, air pollutants may have different forms such as gaseous, smoke, mist, aerosol and

https://doi.org/10.30684/etj.34.11A.4
2412-0758/University of Technology-Iraq, Baghdad, Iraq

particulate matter [2]. Throughout the world, urban areas are developing at rapid pace. Increasing urban populations and growing levels of motorization have inevitably led to air pollution related problems. With geographic information system (GIS), the area and the level affected by air pollution can be displayed more precisely and objectively [3]. GIS technology allows locating the pollutants source and monitor those areas for change to conserve the quality of air, providing boundary condition to the air quality models was done by using GIS ,furthermore using of GIS modelling in air pollution for processing the surface data .[4,5,6] The purpose of this study is to investigate the amount of in situe ground measurements of gasses (H_2S , NO_2, SO_2, VOCs)pollutants . Also using GIS Techniques for mapping air pollutants spatial distribution dispersion for these pollutants over AL-Nahrawan suburban Air pollution maps can be serves as a basis for proper distribution of air pollution measurement stations

Urban Air Pollution

The economic and industrial growth in the last century was the main cause of the massive increase in emissions of air pollutants resulting in an important environmental problem throughout the world[7].Urban environment is stressed by a number of common problems such as population, industrial and commercial growth, increasing energy and transportation demands.[8] Pollution from the combustion of fossil fuels is largely emitted into the outdoor air, but human exposure occurs at both indoors and outdoors[9] air pollution can be categorize as a primary air pollutants that are directly enter to the atmosphere and known to be harmful at enough concentration. And Secondary air pollutant is known to be harmful at enough concentration and it's formed from primary pollutants due to chemical reaction between two or more components. [10]

Nitrogen Dioxide (NO_2)

Nitrogen oxides are generated at high temperature from nitrogen and oxygen in the air [11] Nitrogen dioxide (NO_2) is a colored gas, which is light yellowish orange to reddish brown at relatively low and high concentrations [12]. The most important source that releases the outdoor NO_2 is automobile exhaust, where it's a fore bonding of photochemical smog in urban and industrial areas. NO_2 is an oxidant pollutant, although it is less chemically reactive and thus less likely to induce airway inflammation [13, 14, 15], but can causes a respiratory problems (asthma, lungs infection) , especially in children . Also NO_2 is also a main component in the formation of ozone at the surface level. Highly concentrations of nitrogen dioxide can affect visibility though creation of a 'reddish brown' haze.[16] NO_2 comes from wide sources, these sources include stationary sources, and automobile exhaust such as fossil fuel burning, industrial boilers, incinerators and home space heaters[17]

Hydrogen sulfide (H_2S)

Hydrogen sulfide (H_2S) is a colorless gas having smell of rotten eggs. It is extremely toxic and harmful even at low concentration.[18] H_2S is a natural component that is occurring of crude oil and natural gas . [19] Hydrogen sulfide odor is readily detectable by humans at very low concentrations [20] the main releases of H_2S into the air are caused by industrial process such as paper manufacturing, the extraction and refining of oil and natural gas [21] ; yet, sewage treatment plants, manure-handling plants, tanneries, and coke oven plants also contain Hydrogen Sulfide [22]

Sulfur Dioxides (SO_2)

SO_2 is a non-flammable, non-explosives, colorless gas that can cause the taste sensation at concentrations from 0.3 ppm to 1.0 ppm in the air. The gas has a pungent and irritating odor at a concentration above 3.0ppm [23] a number of sulfur compounds are released to the outdoor air from natural and industrial sources. Natural sources of atmospheric sulfur are considered into

two groups that is biogenic and non-biogenic sources. Emissions from non-biogenic sources are volcanic activities and the burning of biomass.[24] SO_2 formed when fossil fuels like coal, gas and oil are used for generating power [25]

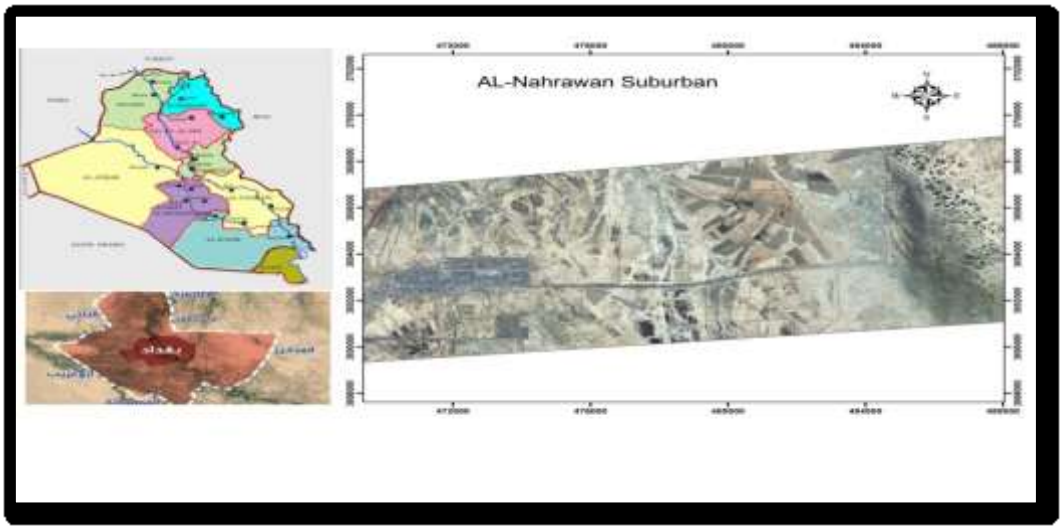
Volatile Organic Compounds (VOCs)

The U.S. Environmental Protection Agency (U.S. EPA,2009) defines Volatile organic compounds (VOC) means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions.[26]

Materials and Methods:

Study Area

The city of Baghdad is the economic, cultural and political capital of Iraq, situated on the banks of Tigris River at the northwest end of the alluvial plain. It covers 4555km^2 which represented 1% from total area of Iraq (435052 km^2)[27]. Fig(1) AL- Nahrawan suburban is located in the south –east part of Baghdad city , the capital of Iraq .it lies about 65 km from it .It was created in 1988 and its population is about 150000.[28]



Figure(1):(A) Digital map of Iraq showing the location of Baghdad governorate (B)The satellite image of AL-Nahrawan suburban (Spot 7 with resolution 1.5 m)

Ground-Base Measurements

Pollutant concentrations were recorded at 6 different locations in AL-Nahrawan suburban (Figure 2) by using MiniRAE 3000 detector for volatile organic compound (VOCs) , and NOVA Device, The Nova 600 Series Portable Multi-gas and single –gas Ambient Air analyzers are convenient and accurate portable instruments for monitoring up to six gases simultaneously from ambient air samples. Here we use for measuring gasses (SO_2, H_2S, NO_2 , VOC_S)Pollutant concentrations measured in parts per million (ppm). Figure 2 shows AL-Nahrawan Bricks factory (spot satellite image with resolution 1.5m) and the sites of gasses measurement.

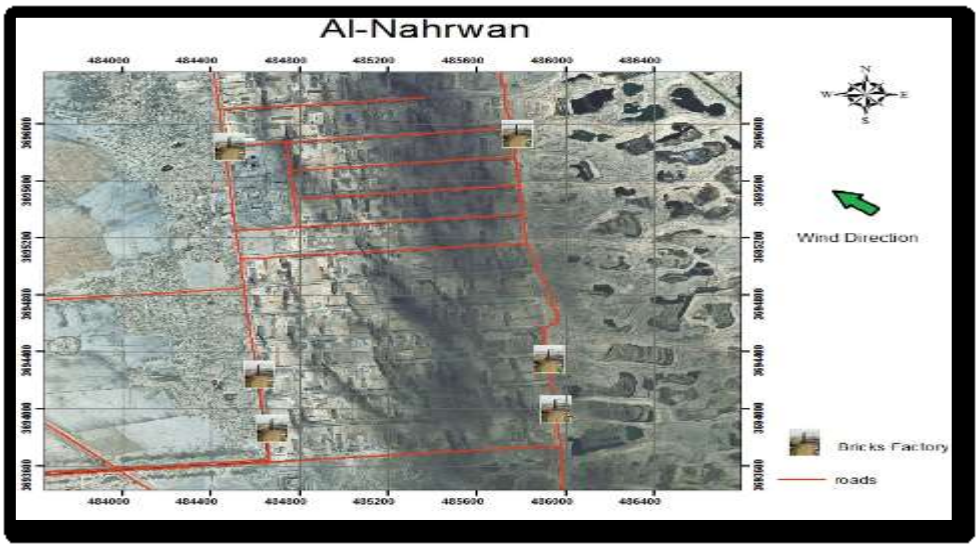


Figure (2): Satellite image of study area showed the sites of gasses measurement.

Local and global standard for air pollutants

Table (1): Local and global standard of some air pollutants (Ministry of Environment - Air Pollution Department for the year 2008)

NO.	*Air pollutant*	*World Limits WHO*	*National Limits*
1.	Nitrogen Dioxide ppm NO2	hour 0.11 ppm 24hour /150 µg/m^3 year / 40 µg/m^3	hour 0.25 ppm/ year/ 0.05 ppm
2.	Sulfur Dioxide SO2 ppm	hour 0.01 ppm / year/ 0.03 ppm	hour 0.14ppm / year/ 0.002 ppm
3.	Total Suspended particle TSP µg/m^3	hour /150 µg/m^3 year / 60-90 µg/m^3	Year24 / 350 µg/m^3 year/ 150 ppm
4.	PM10 PM2.5	24hour /150 µg/m^3 24hour /35 µg/m^3	24 hour/350 µg/m^3

Results

Table (2, 3) shows the result of gasses measurement in two months (February, May). For six sites chosen in AL-Nahrawan suburban, these values in each table represent the average value for sites. Where each point was measured for 10 minutes these 10 minutes gives a ten value for the point and then taking the average value for it.

Table (2): Gasses concentrations measurements in the sites of studied area (ppm) in February period 2015

NO.	H_2S (ppm)	SO_2 (ppm)	NO_2 (ppm)	VOCs (ppm)
1.	0.339	0.198	0.099	0.038
2.	0.235	0.057	0.102	0.165
3.	0.472	0.021	0.103	0.004
4.	0.195	0.024	0.097	0.037
5.	0.33	0.145	0.086	0.084
6.	0.235	0.02	0.165	0.024

Table(3): Gasses concentrations measurements in the sites of studied area (ppm) in May period 2015

NO.	H_2S (ppm)	SO_2 (ppm)	NO_2 (ppm)	VOCs (ppm)
1.	1.0004	0.328	0.373	0.167
2.	0.993	0.423	0.588	0.202
3.	1.065	0.499	0.782	0.203
4.	0.903	0.515	0.751	0.185
5.	0.891	0.581	0.77	0.211
6.	0.976	0.76	0.827	0.192

Air Pollution Dispersion Maps

The gasses concentrations of 6 different locations for two months (February and may) were imported to geographical information system environment to drive maps of air pollution dispersion for AL-Nahrawan suburban. Arc GIS Spatial analysis extension used to produce air pollution dispersion maps by conducting an IDW interpolation on the air pollutant measurement.

Surface maps of these gasses dispersion are shown in the figure 3. Which show the result of February and May (2015) of all measured gasses. The six locations have been chosen depending on the wind direction and the most important pollutant sources in the study area. The wind speed and direction are changing rapidly.

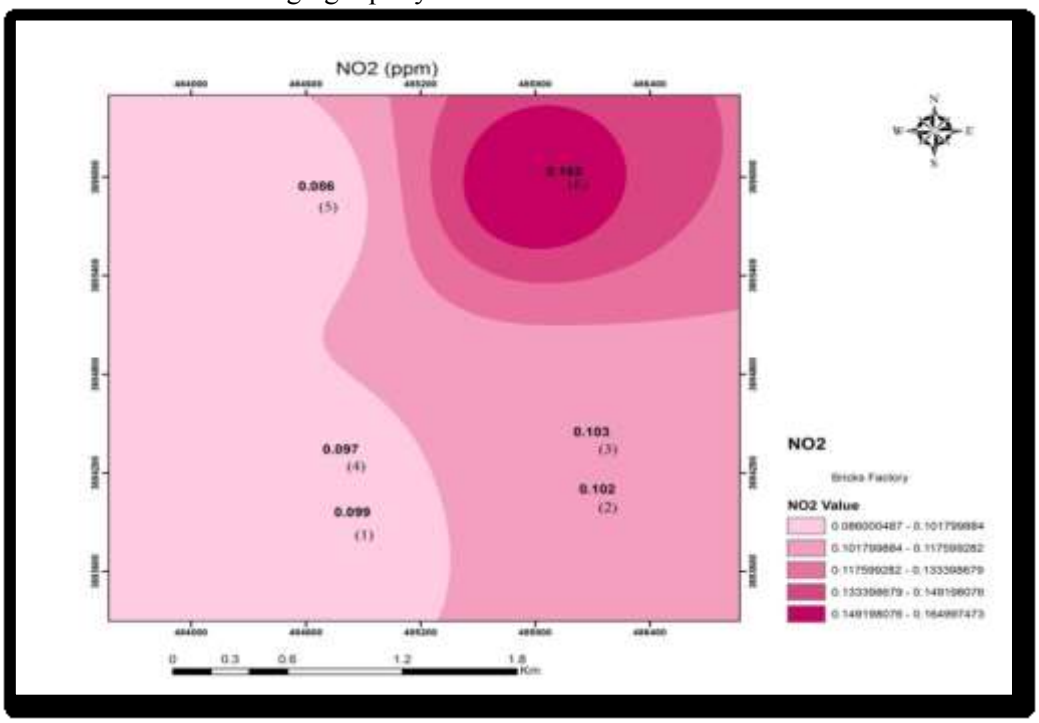
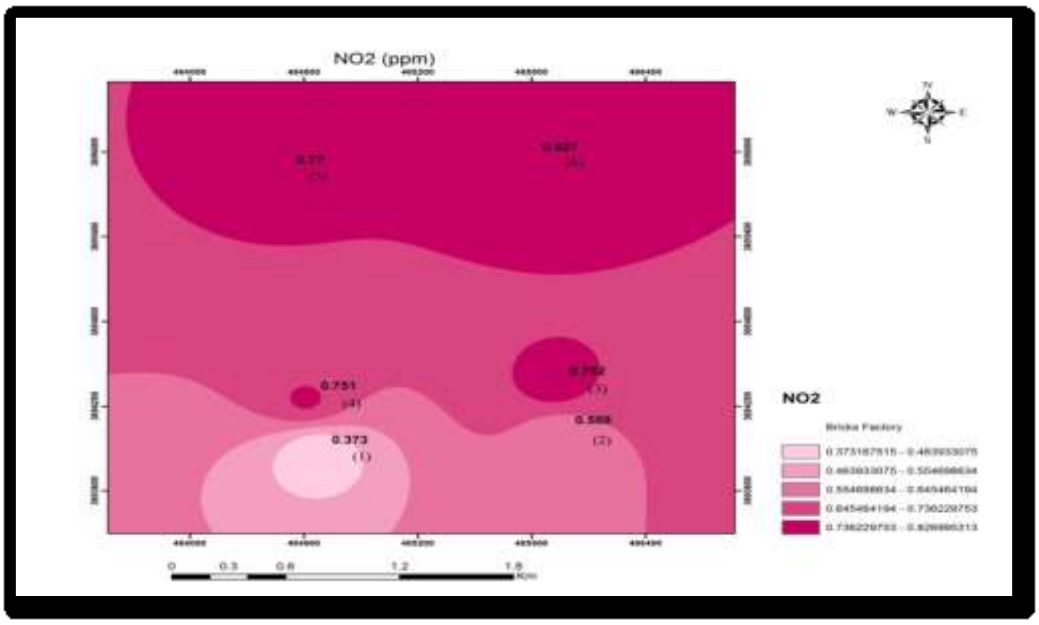


Figure (3) –A : NO_2 distribution in air of the studied area on February 2015.



Figure(3)-B : NO_2 distribution in air of the studied area on May 2015.

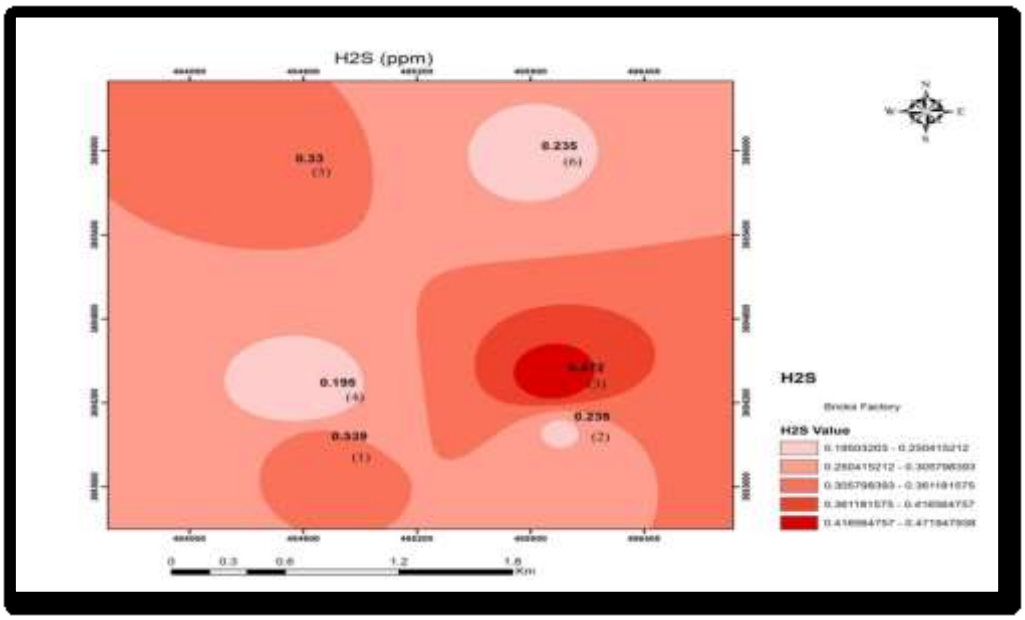


Figure (4)-A : H_2S distribution in air of the studied area on February 2015.

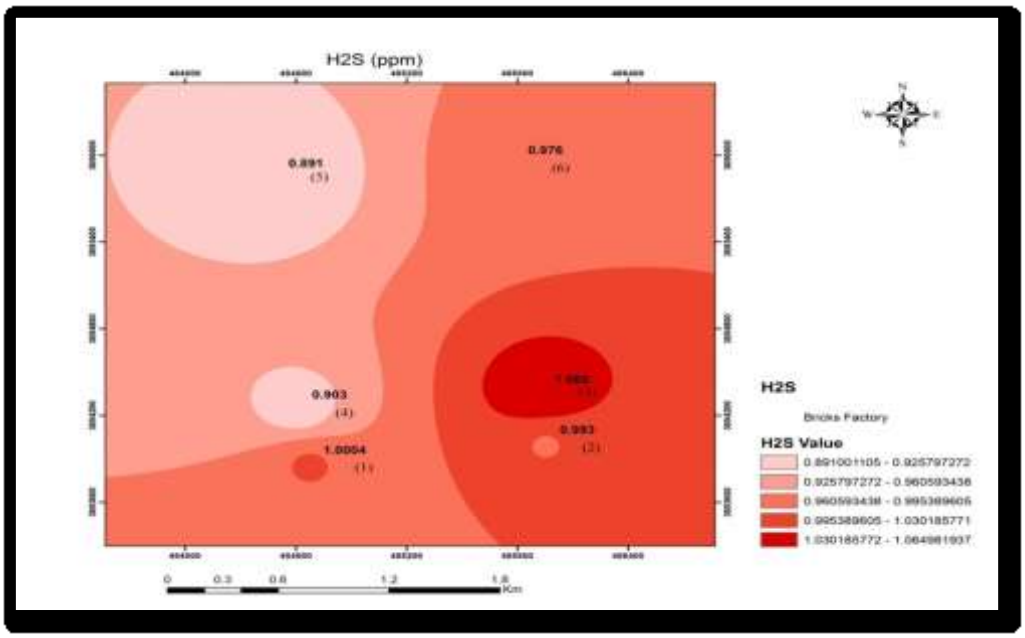


Figure (4)-B : H_2S distribution in air of the studied area on May 2015.

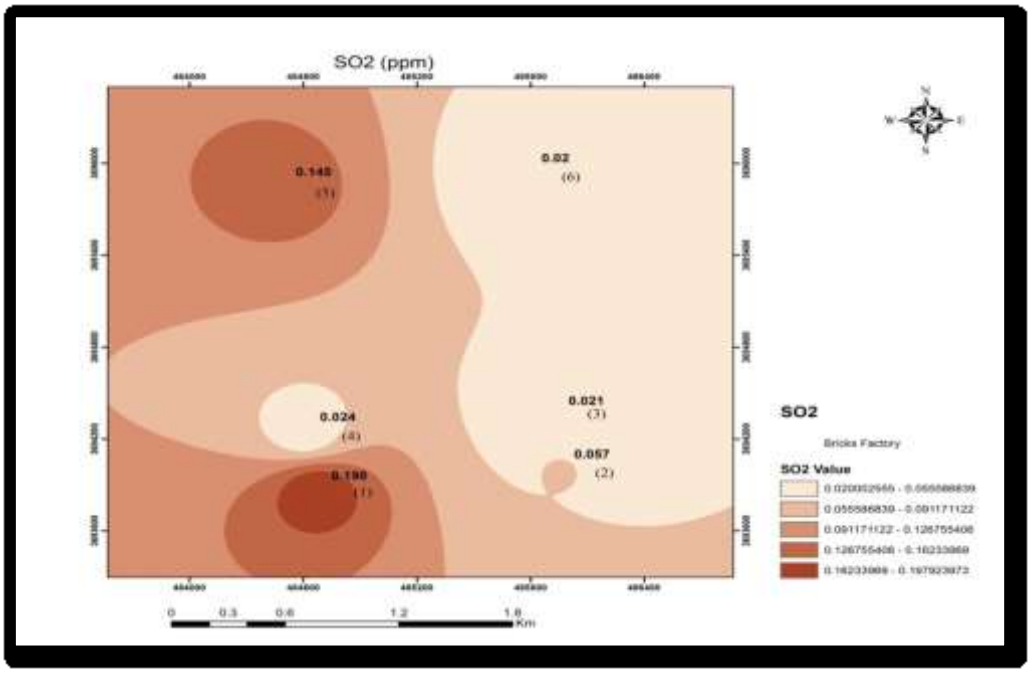


Figure 5-A : SO_2 distribution in air of the studied area on February 2015.

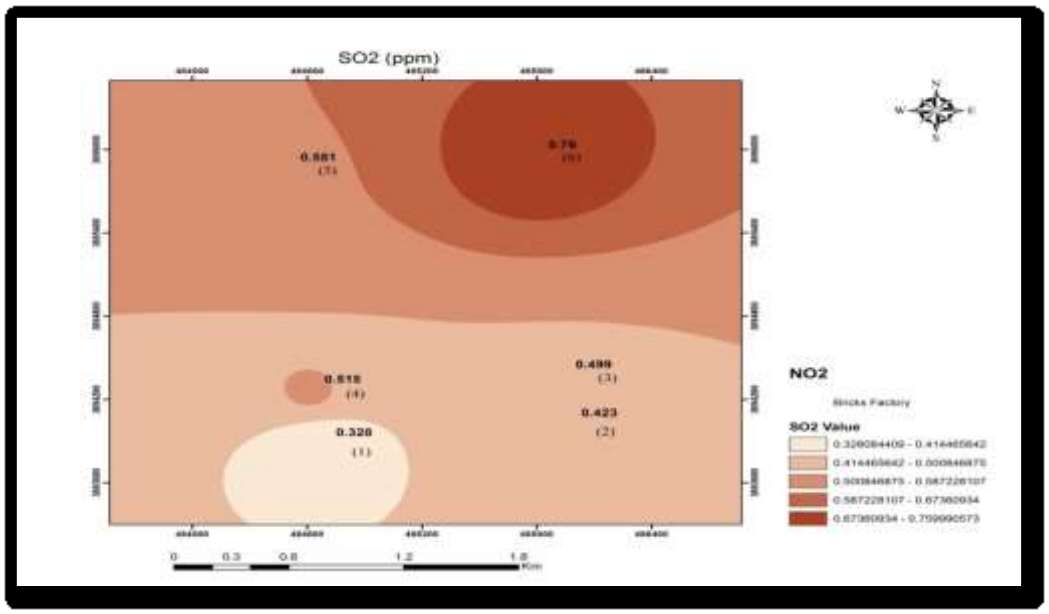
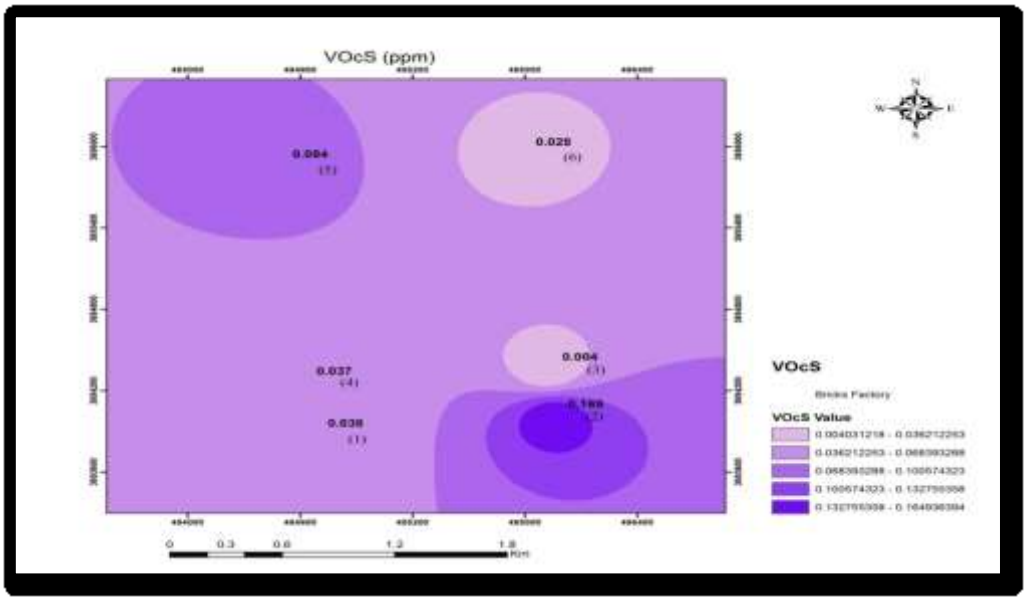


Figure (5)-B : SO_2 distribution in air of the studied area on May 2015.



Figure(6)-A : VOCs distribution in air of the studied area on February 2015.

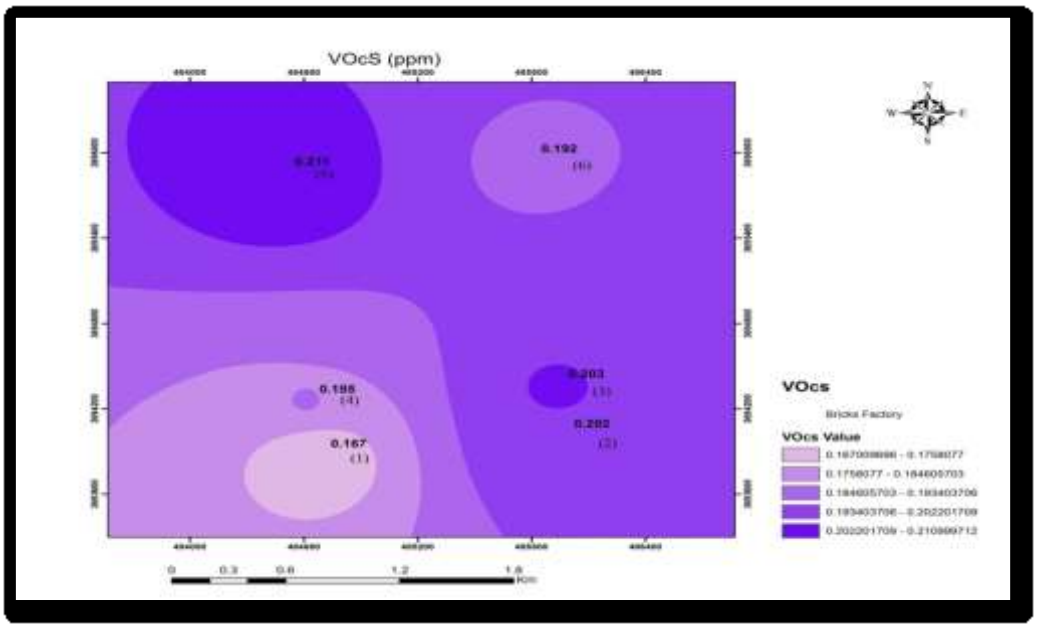


Figure 6-B : VOCs distribution in air of the studied area on May 2015.

Discussion

After finishing the experimental work and measurement (pollutants gasses), (VOCs, SO_2, NO_2, H_2S) in the study area (AL-Nahrawan) the results differ from point to point depending upon the meteorological situation within the measuring period and position of the experimental site and the type of fuel used in the study area, where the average concentration of Sulfur Dioxide gas (0.245 ppm), Average concentration of Nitrogen Oxide gas is (0.37 ppm), which is higher than the allowable National and Iraqi limit in the most selection site. While H_2S is highly found in the site No.1 (1.0004 ppm) and site No.3(1.065 ppm) in May period**.** The industrial process represents by brick factory and tanning factory considered the main reason for high level of pollutants in AL-Nahrawan area.

Conclusions

This work has analyzed and visualized the gasses in AL-Nahrawan suburban where the concentration of sulfur dioxide ,hydrogen sulfide , Nitrogen Dioxide , and Volatile Organic Compounds are higher than the allowable National and Iraqi limits in the most examined sites, and the high values of these gasses are caused by the bricks factories and tanning factory , these gasses values change from season to another which may be caused by many reasons and the most important one was the wind speed and direction which may have influence on the direction of movement of these pollutants ,the temperature ,humidity and the movement of vehicles which transport the production from producing area and the type of oil used (black oil), (heavy oil) which considered as the main reason for released these pollutants to the air , Generally ,Arc GIS air pollution maps can be used as a basis for proper distribution of appropriate locations of air pollution measurement stations.

REFRENCE

[1].Goyal P., Sidhartha." Present scenario of air quality in Delhi: a case study of CNG implementation", Atmospheric Environment, Vol 37, 5423-5431,2003.

[2].Alias Masitah, Hamzah Zaini and Kenn Lee See." PM10 and Total suspended particulates (TSP) measurements in various power stations", The Malayasian Journal Of Analytical Sciences, Vol 11, No 1, (2007): 255-261.

[3].Myoung-Young PIOR, OmarOsman, "Air pollution assessment applying GIS integrated system " , Journal of the Eastem Asia Society for Transportation Studies, Vol. 2, No. 6, 1997.
[4].Song S. J. ," A gis based Approach to Spatio-Temporal Analysis of Urban Air Quality in Chengdu Plain", The International Achieves of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol. 37. Part B7, Beijing, 2008.
[5].Yerramilli A., Dodla V. B. R. and Yerramilli S.," Air Pollution, Modeling and GIS based Decision Support Systems for Air Quality Risk Assessment".,Earth and Planetary Sciences, Oceanography and Atmospheric Sciences "Advanced Air Pollution", book edited by Farhad Nejadkoorki, ISBN 978-953- 307-511-2., 2011.
[6].Longley, P. A., Goodchild, M. F., Maguire, D. J., and Rhind, D. W.," Geographic Information Systems and Science", John Wiley & Sons, 27–58, New York, 2001.
[7].D'Amato G, Liccardi G, D'Amato M.," Environmental risk factors (outdoor air pollution and climatic changes) and increased trend of respiratory allergy". J Invest Allergol Clin Immunol. 2000; 10:33-9.
[8].S. Enrique Puliafito*, Miguel A. Gantuz, Carlos M. Puliafito, "A GIS model for urban air quality analysis", Mec´anica Computacional ,Vol. XXIII, pp. 1787-1806,2000.
[9].Ozkaynak H ,"Exposure assessment. In: Air pollution and health",. Holgate ST, Samet JM, Koren HS, Maynard R, eds. Academic Press, London. 1999.
[10].anil kumar singhdeo, and nilamadhab suna," Monitoring of Sulphur dioxide, nitrogen oxides, pm10 and tsp present in the ambient air of nit Rourkela" ,thesis in bachelor of technology in civil engineering , national institute of technology Rourkela, 2009.
[11]Colls, J.," Air Pollution", 2nd Edition., London: New Fetter Lane ,book edited by Bill Bassett, Honorarry Fellow ,ISBN 0-203-46602-6, 2002.
[12].Wittiga,A. E., Anderson, N., Khlystov, A. Y., Pandis, S. N., Davidson, C. and Robinson, A. L. ," Pittsburgh Air Quality Study Overview", Atmospheric Environment. 38, pp. 3107–3125, 2004.
[13].Peden DB., Yunginger JW, Busse WW, Buchner BS, Holgate ST, Simons FE, .," Air pollution: indoor and outdoor.", In Adkinson NF, Editors. Middleton's Allergy: Principles and practice. Philadelphia: Mosby, 2008, pp.495-508.
[14].Gauderman W, Avol E, Lurmann F, Kuenzli N, Gilliland F, Peters J, McConnell R, "Childhood Asthma and exposure to traffic and nitrogen dioxide",. Epidemiology. 2005;16:737-43.
[15].de Marco R, Poli A, Ferrari M, Accordini S, Giammanco G, Bugiani M, Villani S, Ponzio M, Bono R, Carrozzi L, Cavallini R, Cazzoletti L, Dallari R, Ginesu F, Lauriola P, Mandrioli P, Perfetti L, Pignato S, Pirina P, Struzzo P, ISAYA study group, Italian Study on Asthma in Young Adults," The impact of climate and traffi crelated NO2 on the prevalence of asthma and allergic rhinitis in Italy", Clin Exp Allergy;32:1405-12. 2002
[16].Air pollutants and air quality terms, Air quality monitoring network, 2008
[17].Harrison, R. M. ,"Pollution: Causes, Effects and Control", Second Edition. Cambridge: The Royal Society of Chemistry ,1992
[18]. Ahluwalia, V.K., Malhotra,S.," Environmental Science",an a book, Pvt. Ltd. Gopaljee Enterprises, India, 2006.
[19].Lana Skrtic , "Hydrogen Sulfide ,Oil and Gas ,and Peoples Health" ,University of California, Berkeley Paper submitted for the fulfillment of a Master's Degree, Energy and Resources Group,2006.
[20]. Ambient Air Guidelines for Hydrogen Sulfide CAS Registry Number 7783-06-4 (March 27)(Environmental & Occupational Health Program Division of Environmental Health Maine Center for Disease Control & Prevention Maine Department of Health & Human Services), 2006
[21].New York State Department of Health: available at http://www.health.state.ny.us/nysdoh/environ/btsa/sulfide.htm

[22]. "Public Health Statement for Hydrogen Sulfide," Agency for Toxic Substances and Disease, September 2004.
Available at http://www.atsdr.cdc.gov/toxprofiles/tp114-c1.pdf
[23]. Wark, K. and Warner, C.F. ," Air Pollution; Its Origin and Control", New York: Purdue University, A Dun-Donnelley Publisher. 1976.
[24]. Taerakul, P., Characterization of Trace Elements in Dry Flue Gas, 2005
[25]. Lenz, H.P. and Cozzarini, C.," Emissions and Air Quality",. Warrendale, Pa. Society of Automotive Engineers, Inc, 1999.
[26]. Ahmed Haytham A.," Air Quality in Egypt", Air Quality Monthly Report, Monthly report, August 1999.
[27]. Saleh, S.A. H., "Impact of Urban Expansion on Surface Temperature in Baghdad, IRAQ using Remote Sensing and GIS Techniques", University of al-Nahrain, Baghdad, Iraq, Canadian Journal on Environmental, Construction and Civil Engineering,2(8) 2011.
[28]. Investor guide of Baghdad,: This report was produced for review by the U.S. Agency for International Development (USAID). It was prepared by The Louis Berger Group, Inc. 2011.